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PROJECT CHECO SOUTHEAST ASIA REPORT

THE EC-47 IN SEA APRIL 1968 - JULY 1970

Special Report

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PROJECT CHECO
Contemporary Historical Examination of Current Operations REPORT

THE EC-47 IN SEA (U)
APRIL 1968 - JULY 1970

12 SEPTEMBER 1970

HQ PACAF
Directorate, Tactical Evaluation
CHECO Division

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PROJECT CHECO REPORTS

The counterinsurgency and unconventional warfare environment of Southeast Asia has resulted in the employment of USAF airpower to meet a multitude of requirements. The varied applications of airpower have involved the full spectrum of USAF aerospace vehicles, support equipment, and manpower. As a result, there has been an accumulation of operational data and experiences that, as a priority, must be collected, documented, and analyzed as to current and future impact upon USAF policies, concepts, and doctrine.

Fortunately, the value of collecting and documenting our SEA experiences was recognized at an early date. In 1962, Hq USAF directed CINCPACAF to establish an activity that would be primarily responsive to Air Staff requirements and direction, and would provide timely and analytical studies of USAF combat operations in SEA.

Project CHECO, an acronym for Contemporary Historical Examination of Current Operations, was established to meet this Air Staff requirement. Managed by Hq PACAF, with elements at Hq 7AF and 7AF/13AF, Project CHECO provides a scholarly, "on-going" historical examination, documentation, and reporting on USAF policies, concepts, and doctrine in PACOM. This CHECO report is part of the overall documentation and examination which is being accomplished. Along with the other CHECO publications, this is an authentic source for an assessment of the effectiveness of USAF airpower in PACOM.

[illegible], Major General, USAF
Chief of Staff

DEPARTMENT OF THE AIR FORCE
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FOREWORD

"The EC-47 in Southeast Asia," a Project CHECO Report published 20 September 1968, examined the USAF effort in ARDF (Airborne Radio Direction Finding) from its SEA inception in 1962 through April 1968. Since that time, several changes in equipment, relocation of tactical electronic warfare squadrons (TEWS), and concomitant moves of the detachments of the 6994th Security Squadron have necessitated this updating of the original report.

The function of the program--that of locating and fixing the positions of low-powered enemy transmitters, and of gathering intelligence from these emissions, in a near-real-time sense--remains the same as of this writing. The operation, with the exception of the activities of an EC-47 detachment at Nakhon Phanom, Thailand, had previously been called "Combat Cougar". Because of a suspected compromise of the nickname, the project was renamed "Combat Cross" by CSAF message 251548Z June 1970, and all references to the program in this report will reflect the change.[1/] The Thai-based detachment, operating exclusively over Laos, was designated "Commando Forge."

The sensitive nature of some aspects of the Combat Cross/Commando Forge mission has acted as a restraint on any acknowledgment of the degree of success achieved by the ARDF function, but unofficial comment by ground commanders benefitting from its real-time electronic

reconnaissance has invariably been highly favorable. Within the limitations imposed by the need to protect sensitive information, this CHECO report documents the operations, functions, organizational changes, and achievements of the USAF/ARDF function in SEA from April 1968 through July 1970.

Lessons learned in World War II and Korea were rapidly forgotten--or, perhaps, "neglected" is a better word. Because of security considerations or because of the lack of glamor often necessarily resulting from this cloak, such valuable techniques as Airborne Radio Direction Finding appear to "get lost" in the aftermath of a conflict.[2/] (These words were paraphrased from a 460th Tactical Reconnaissance Wing report, "A Critical Review of the ARDF Operations in SEA.") It is hoped that this CHECO report, along with the previous report, "The EC-47 in Southeast Asia," will help keep this valuable asset alive and subject to continued review and analysis relative to its role in tactical air warfare.

Although in theory the USAF and the U.S. Army jointly supported the ARDF/COMINT role in SEA equally, USAF efforts provided 70 to 75 percent of real-time fixing of enemy radio transmissions to field commanders.[3/] Nevertheless, because of an agreement between the Air Force and Army Chiefs of Staff, any doctrinal issues arising from this seeming imbalance would have to wait until the end of the SEA conflict for resolution.

CHAPTER I

COMMAND AND CONTROL

Regardless of the direction taken in roles and missions or command and control of the ARDF function following the SEA hostilities, it was made abundantly clear from the outset that in Vietnam, and subsequently in Laos and Cambodia, ARDF was to be ground-oriented. Pertinent to the ARDF mission was an 11 September 1967 memorandum signed by the Army and Air Force Chiefs of Staff, which stated in part:[1/]

> *We agreed that for the short term and the duration of the war in Vietnam, we would continue to jointly support the MACV requirements, with each of us furnishing equipment as may be jointly agreed upon between the Chief of Staff of the Army and the Chief of Staff of the Air Force in accordance with our respective capabilities, recognizing the time frames in which the equipment is required by MACV.*

A memorandum from the Deputy Secretary of Defense, Mr. Paul H. Nitze, on 19 June 1968, left no doubt about the subject:[2/]

> *...airborne communications intercept and direction finding in South Vietnam are COMINT activities which should be assigned in direct support of and under the operational control of MACV.*

The memorandum left questions about the future unanswered, but for the duration of the Southeast Asia war placed the direction of the ARDF mission and its associated intelligence data-gathering

functions firmly in Army-oriented hands. From the initiation of Air Force ARDF operations in SEA, COMUSMACV made it clear that all ARDF resources would be used only in response to his "approved requirements".

MACV J-2 (specifically MACV J211-4) was designated as the office of primary responsibility (OPR) for all SEA ARDF matters. The office had responsibility for acting as intelligence-requirements control authority, designating consumers for ARDF results, and passing these results on to the consumers.[3/]

MACV J-2, acting upon requests for ARDF assistance from field commanders, the cryptologic/intelligence community, Hq 7AF and other consumers, proposed a weekly allocation of aircraft sorties to satisfy the necessary coverage.

The weekly tasking meeting was chaired by MACV J-2 and was attended by representatives of the Army's 509th Radio Research Group (RRG), the Air Force's 6994th Security Squadron and Hq 7AF's intelligence and operations people, the National Security Agency (NSA), COMNAVFORV, and Controlled American Source (CAS) personnel.[4/] The group translated the general requirement levied by MACV into approved and detailed tasking for further transmission to the action agencies through the ARDF Co-ordinating Center (ACC). The ACC provided the 509th RRG, 6994th SS, and Seventh Air Force with a weekly requirements schedule listing daily missions and sorties, desired initial target times, Universal Transverse Mercator (UTM) coordinates of the various mission areas, and

priorities.[5] (See Figure 1 for communications channels of tasking and fragging.)

FRAGGING PROCESS

The issuance of fragmentary orders for Combat Cross/Commando Forge aircraft was done on a daily basis by Hq 7AF DOCRS, based on the weekly tasking message from the ACC. Prior to late spring of 1970 this was done manually; however, as of 4 April 1970, the daily frag order was processed through the Seek Data II 1130/360 computer systems.[6] A test run, starting 21 March and ending 3 April, was made using both the automated and manual systems to identify and correct any deficiencies in the new process.[7]

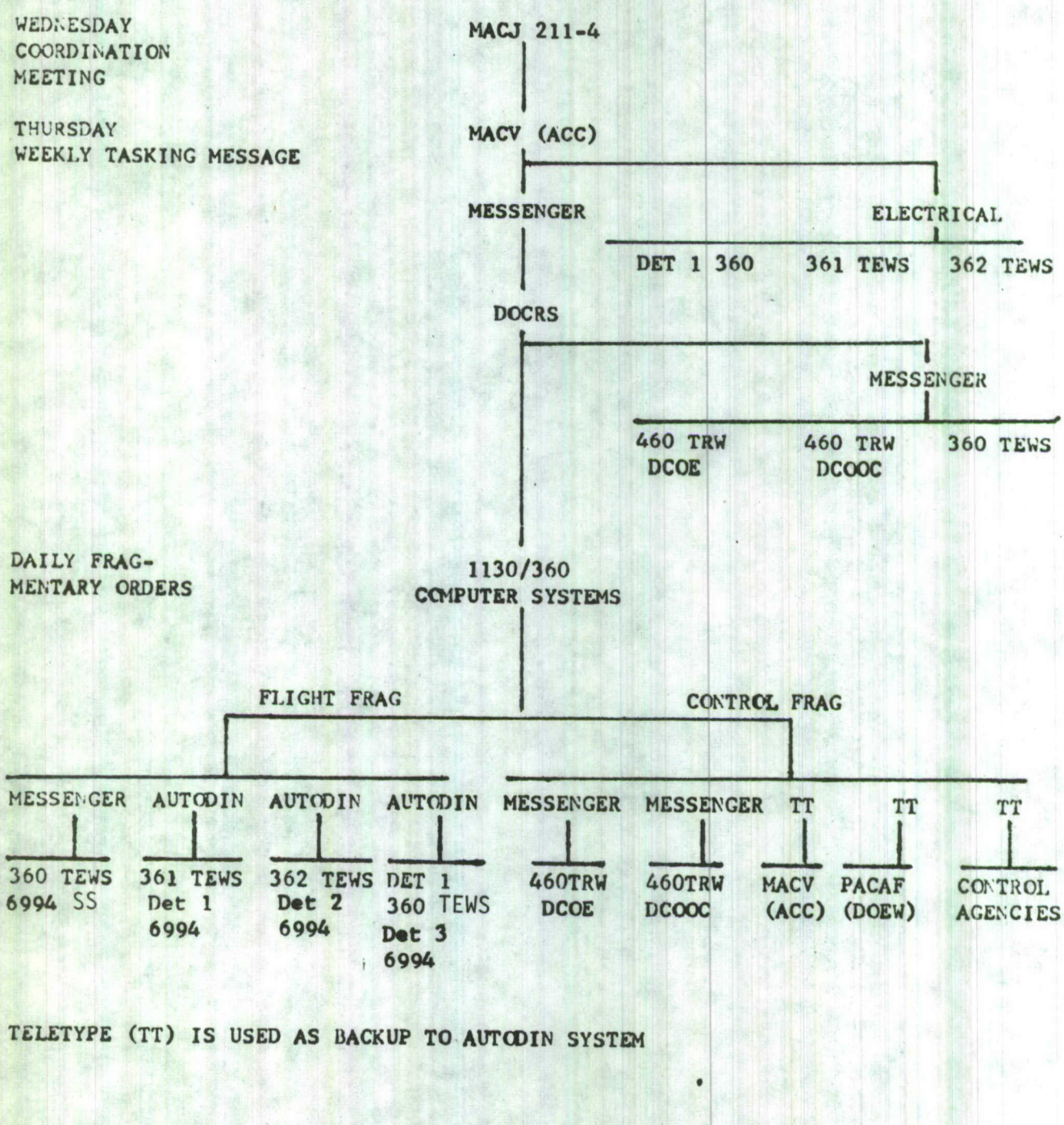
From that time on, the daily fragmentary order was processed and released by Hq 7AF no later than 0900H, using AUTODIN (Automatic Digital Network) as the primary method of transmission. If transmission by AUTODIN was not possible within three hours, the frag order was transmitted by teletype.[8] The goal was to frag for a 75 percent rate for the 57 UE (Unit Equipment) EC-47 aircraft, but, in practice, fragging was performed on the basis of possessed aircraft on a weekly basis (some days it might drop to 60 percent, other days up to 80 percent-plus, but, over the week, 75 percent was maintained).[9]

AUTHORIZED, ASSIGNED, POSSESSED - THE DIFFERENCE

The difference between UE, assigned, and possessed aircraft must be stressed, since it had a significant impact upon the fragging process. UE stood for the number of aircraft (57) authorized the 460th Tactical Reconnaissance Wing for ARDF purposes; in actuality, only 52 were assigned, as of July 1970. Of the 52 EC-47s assigned, on the average, seven-plus were lost to the units--being in IRAN (Inspect and Repair as Necessary), undergoing modification, receiving corrosion control treatment, or being ferried--and, in consequence, were dropped from the "possessed" category. This left an average of 45 aircraft to be fragged. Moreover, even some of these, although technically "possessed," were invariably down for organizational maintenance, battle damage repair, or tech order compliance, and could therefore, not be flown; thus it was evident that 75 percent fragging of UE aircraft was not a valid concept. With the concurrence of COMUSMACV, fragging was based on 75 percent of the possessed aircraft. This proved more realistic, in that it allowed for scheduled or unscheduled maintenance, training, equipment calibration, and functional check flights.[10/]

The U.S. Army had a far simpler problem when it came to the tasking and fragging process for its ARDF function, inasmuch as the 509th RRG had direct lines of communication to and control over its aviation assets, Direct Support Units (DSUs), and crews, each member of which had SSIR (Special Security Investigations Required) clearance.[11/]

COMBAT CROSS/COMMANDO FORGE
FRAGMENTARY ORDER PROCESS
IN/OUT COUNTRY



TELETYPE (TT) IS USED AS BACKUP TO AUTODIN SYSTEM

FIGURE 1

In Air Force operations the process was complicated by the fact that two separate organizations were considered necessary to accomplish the mission. The 460th TRW provided the platform and "front end" crews, while the 6994th Security Squadron furnished SI-cleared "back end" crews for operations of the ARDF and intelligence collection systems. Flight frags were issued for front end crews, to tell them where to go; control frags were used for tactical air control, and command and control purposes. Detailed instructions on what to look for, fix, or collect were provided to back end crews by the ACC. The navigator, although provided by the 460th TRW, had to work in close coordination with the back end people, and so was SI cleared. 12/

Also true, however, was the inescapable fact that, in the cramped confines of the EC-47, with the lavatory back behind the equipment and operators, the front end crew flying seven-hour missions day in and day out, could not help but be cognizant to some degree of the sensitive aspects of the mission. Recognizing this, and aware that full crew integrity would be beneficial to over-all mission accomplishment, the 460th DCOE forwarded a letter to the 7AF Air Force Special Security Office (AFSSO) requesting that all crew members be granted SSIR clearance, in addition to their already-required Top Secret clearance. Once this was accomplished, the front and back end personnel should be able to work together as a more effective team. By AFSSO USAF message, dated 031834Z August 1970, authority to clear and indoctrinate front end crews was granted. 13/

EXTENT OF CONTROL

Although MACV was a joint command, representing all services, it was heavily Army-dominated at all levels. (This situation extended into the realm of doctrine, discussed further in Chapter V.) On 8 March 1968 COMUSMACV designated his Deputy Commander for Air Operations (Commander, Seventh Air Force) as the Single Manager for control of tactical air resources in South Vietnam and the extended battle area.[14/] This control was to be over all fixed-wing tactical strike and reconnaissance forces, as well as USAF airlift assets, but would not include Army and USMC helicopters and airlift.[15/] Ample documentation exists, however, to show that COMUSMACV did not consider this concept to include control of the Air Force ARDF assets and efforts, although they were "fixed wing," "USAF," and "performing a reconnaissance mission." Deployment and redeployment of the TEWS, or even individual aircraft, could not be made without MACV study and concurrence. Concerning this, a Thirteenth Air Force Operations Plan (13AF OPLAN 5C21, 7 January 1970) stated that Seventh Air Force "will provide four EC-47s if the plan is implemented." On the same subject, the 7AF DCS/Operations wrote the Director of Plans that:[16/]

> *COMUSMACV is the single manager of all existing and programmed ARDF resources in his area of responsibility. This authority is contained in MACV Directive 381-23, April 1969, and originates from a SECDEF Memo of 19 Jun 1968, subject: ARDF Resources. We do not have authority to deploy EC-47s without MACV approval.*

CHAPTER II

DEPLOYMENT - REDEPLOYMENT

In April 1968 Seventh Air Force received official word that ten additional ARDF-configured aircraft were ready for deployment to SEA. These ten, which would increase the TEWS UE from 47 to 57 aircraft, would be EC-47Qs fitted with R-2000-4 engines, a type more powerful than the R-1830Ds with which the initial EC-47 N/Ps had been equipped.[1/]

Under the parent wing--the 460th TRW at Tan Son Nhut AB--the total April 1968 inventory of EC-47 aircraft was assigned to three TEWS--the 360th TEWS at Tan Son Nhut, the 361st at Nha Trang, and the 362nd at Pleiku. Although until then 47 aircraft were authorized, only 41 were possessed, split among the three locations. Thirteen were at Tan Son Nhut, 15 at Nha Trang, and 13 at Pleiku.[2/]

Collocated with each of the deployed squadrons was a detachment of the 6994th Security Squadron. Det 1, 6994th SS, accompanied the 361st TEWS, and Det 2 was with the 362nd to accomplish the back end functions of "fix" and "take"--"take" being the monitoring of enemy radio transmissions for content.[3/]

By April 1969 acquisition of new platforms brought to 49 the total number of aircraft possessed. Seventeen of these were based at Tan Son Nhut, 16 at Nha Trang, and 16 at Pleiku.[4/]

The plan for de-Americanizing the bases at Pleiku and Nha Trang and subsequently turning them over to VNAF units necessitated a series of decisions concerning relocation of the 361st and 362nd TEWS during the spring and summer of 1969. The possibility of squadron relocations was the subject of considerable message traffic, reaching as high as CSAF level. Hue Phu Bai was considered and rejected, primarily for reasons of maintenance and support, although for a time EC-47s made frequent operational stops at this northernmost RVN base.[5/]

Nha Trang was already phasing down, with U.S. units redeploying to Cam Ranh Bay and other bases. On 18 September 1969 the 361st TEWS and Det 1, 6994th Security Squadron, relocated to Phu Cat, some 100 NM north of Nha Trang.[6/] This move solved part of the problem, but the relocation of the 362nd TEWS from Pleiku was not so easily disposed of, involving as it did tri-service movements and multi-government discussions before final resolution. Among the many factors considered, reviewed, rejected, discussed, and modified before the final deployment were these:[7/]

- Support at Pleiku as to become marginal after 1 April 1970, and nonexistent after June 1970.
- Nakhon Phanom, Thailand, was considered optimum for squadron location, for Barrel Roll and north Steel Tiger coverage, but could not be used, because of headroom problems. Pull-out of other units from Thailand would not ease the problem, inasmuch as it would be accompanied by simultaneous headroom reduction on the part of the Thai government.
- Relocation of the 362nd TEWS to Hue Phu Bai or Chu Lai was ruled out, because the rationale for selection of Danang was primarily optimization of operational posture and availability of support.

- No other airfield in RVN was operationally acceptable for relocation of the 362nd TEWS, because of increased distances to target areas.

- COMUSMACV desired relocation of the 362nd to Danang, but awaited a message from CG III MAF regarding the impact of the relocation of the Army's 138th Aviation Company from Danang to Hue Phu Bai, which would be necessary prior to redeployment of the 362nd from Pleiku to Danang.

- A 7AF Draft Programmed Action Directive envisioned relocating the 362nd to Phu Cat with an operating location (OL) for six aircraft at Danang. COMUSMACV disagreed and requested 7AF to recommend alternate locations which would permit maximum time over target in northern I Corps and Steel Tiger areas of operation.

- COMUSMACV stated that the 362nd TEWS would relocate to Danang and that the 138th Aviation Company would relocate to Hue Phu Bai, although the 362nd would have to operate temporarily with 100 feet less ramp space than really needed, pending reduction of a USMC fixed-wing refueling unit.

These were but a few of the many convolutions involved in the movement and final beddown of the 362nd TEWS, but they do cover most of the salient points. On 19 June 1970 the 362nd TEWS and Det 2, 6994th Security Squadron, relocated to Danang.

In April 1969 a detachment of three EC-47s from the 460th TRW resources had been stationed at Nakhon Phanom, Thailand (Commando Forge), and in April 1970 this force was increased to five aircraft. These relocations provided more effective ARDF coverage of Southeast Asia than previously, with maximum possible times on target. 8/

COMMANDO FORGE

By mid-1968 it had become increasingly evident that an ARDF/SIGINT (Signal Intelligence) capability would be required outside of Thailand to service CAS and Task Force Alpha (TFA) with EC-47 support.[9] Such a deployment would obviously have widespread doctrinal, operational, and diplomatic impact. It was with this in mind, and with specific warnings concerning operational control, that the CSAF in September 1968, sent a message exploring the subject. Although addressed to CINCPACAF for action, it included as information addressees the Operations, Plans, and Intelligence Offices of Seventh Air Force, Thirteenth Air Force, and Seventh/Thirteenth Air Force. Acting on the planning assumption that as three Sentinel Eagle (R-2000-powered) aircraft entered the SVN inventory, a like number of Combat Cross EC-47s would be simultaneously transferred to Thailand, the CSAF requested PACAF and/or AFSS views on the operational and intelligence basis of:[10]

A. Three EC-47N/P operating from a Thai base, presumably Udorn, 50 hours per aircraft per month, the crew ratio 2.0 or 1.75 at PACAF option. USAFSS 2.0 manning.

B. USAFSS DF/Collecting, processing, reporting, and maintaining a technical data base for Laotian targets.

At the same time, the Air Force Chief of Staff reminded PACAF and AFSS that they should assume that any ARDF/DSU (Direct Support Unit) operation would be a direct support function, with OPCON delegated to 7/13AF. CAS requirements for DF/COMINT collection would be handled as of

the highest priority, operational considerations permitting. That is, the Air Force would not consider placing the DSU/ARDF operation directly under CAS OPCON, but would instead operate on the premise that deployment of unit aircraft was primarily to support CAS requirements.[11/]

The reason why it was necessary for ARDF aircraft to operate out of Thai bases was simply that South Vietnam-based EC-47s did not have the loiter time to cover the North Steel Tiger and Barrel Roll areas with any degree of effectiveness and most of their flying time would be spent in transit to and from target areas. Admittedly, Pleiku-based EC-47s would be the closest to the target areas in Laos, but the 2,500' elevation and considerations of flying safety acted to limit the planes' gross weight. The aircraft could not launch with a full fuel load and retain single-engine capability if an engine failed on takeoff. Sea-level-based aircraft, such as those then based at Nha Trang, could carry the fuel, but would have to fly nearly 300 miles further, to and from target areas, a circumstance which nullified the fuel-load advantage.

Operational considerations were, however, not the only factor affecting the decision as to whether EC-47s should or should not be based in Thailand. Diplomatic concern was also evinced at high level of both the U.S. and Thai governments. In a lengthy discussion at Udorn on 27 February 1969, the purpose and concept of Commando Forge operations were explained in detail to Ambassador Unger.[12/] He in turn explained that much of the problem lay in Royal Thai Government sensitivity

concerning the increase in the number of U.S. cryptologic personnel in Thailand, as well as the fact that Air Vice Marshal Dawee already considered the Task Force Alpha/Infiltration Surveillance Center (TFA/ISC) complex at Nakhon Phanom a "spook outfit".[13/] After it was explained to the Ambassador that Commando Forge activities would not duplicate any existing collection capability or analysis facility, but would, rather replace and improve the current EC-47 collection program for Laos which had to operate out of RVN, he gave his solid support to the program. He stated he would have his staff study the problem of how best to present the case to the RTG, including possible visits to TFA by key Thai officials, and depiction of Commando Forge as an operation "in direct support of the tactical commander," with any "spook" aspect played down.[14/]

With the diplomatic problems eased, one continuing problem area remained, that of headroom in Thailand. The Royal Thai Government was adamant about the number of U.S. servicemen allowed in-country, and even at that time was contemplating a force reduction. Several solutions were offered--most of them involving tradeoffs with other Thai-based units or U.S. Army aviation spaces and elimination of lower priority spaces to accommodate the necessary 144 manpower spaces and three aircraft.[15/] Quite naturally, no one wanted to hurt his own operation by giving up spaces; so for some time the matter was a standoff. Fortunately, management action reducing EB-66 quarterly flying hours by approximately 1,000 hours generated sufficient manpower headroom without increasing the USAF Thailand ceiling, and so opened the way for Commando Forge deployment.[16/]

Detachment 2, 460th Tac Recon Wing, was established at Nakhon Phanom on 6 April 1969 (under operational control of MACV) with three EC-47s.[17/] This force was augmented intermittently throughout 1969 and early 1970 with two TDY aircraft, and was enlarged to as many as seven during periods of critical interest. On 27 April 1970, final approval was received to man five EC-47N/P aircraft at Nakhon Phanom on a PCS basis.[18/] This gave Commando Forge ARDF/SIGINT coverage over most of the permissive Barrel Roll and western Steel Tiger areas. Effective 1 June 1970, Det 2, 460th Tactical Reconnaissance Wing, was inactivated; simultaneously, Det 1, 360th Tactical Electronic Warfare Squadron, was activated at Nakhon Phanom, taking over the personnel and equipment of the former.[19/]

SENTINEL EAGLE DEPLOYMENT

Sentinel Eagle was the nickname assigned the deployment of ten "Super Goon" EC-47Q aircraft to Southeast Asia. The "Q" model, with the basic C-47 airframe but R-2000-4 engines, had better single engine and climb performance than the standard EC-47 using R-1830 engines. Although the EC-47Q aircraft in CONUS had been ready for SEA deployment in April 1968, OSD approval for the program was not received until 28 June of that year.[20/] This followed a lengthy "Roles and Missions" controversy in which MACV proposed a one-for-one tradeoff where each EC-47Q, as it arrived in the theater, would replace an older EC-47N/P, thus keeping the UE down to 47. On the surface this arrangement appeared advantageous, since it would solve headroom problems, facilities construction, and beddown.

However, when it was discovered that the Army had proposed a significant increase in its own fixed-wing intelligence collection forces, the Air Force quickly took violent exception to this maneuver.[21/] Unresolved, the problem was turned over to the "New Focus" committee, a joint USAF/USA organization created specifically to iron out roles and missions controversies, and the EC-47Q eventually came to SEA with a revised UE of 57.[22/]

The first EC-47Q arrived in South Vietnam on 11 September 1968 and was assigned to the 362nd TEWS, then at Pleiku, as were all subsequent arrivals. The assignment of the "Q" models to the 362nd was a natural move from a flight safety viewpoint, since Pleiku, with the highest elevation of any major airfield in Vietnam, could prove fatal for the successful operation of lower-powered EC-47s. Another valid consideration existed: the EC-47Qs were all equipped with the AN/ALR-35 (a second generation version of the ALR-34), and USAFSS recommended that, because of the limited quantity of AGE, they all be assigned to one base. This was directed by Seventh Air Force on 6 September.[23/]

There were seven Sentinel Eagle aircraft in the theater as of 31 December 1968, with three more scheduled for delivery during the next quarter.[24/] Although the figures continued to be revised, as the result of combat loss and damage (discussed later), the average number of Sentinel Eagle aircraft in-country and possessed usually ran between six and nine.

MAINTENANCE FOR DEPLOYED AIRCRAFT

Maintenance of aircraft of the 360th TEWS created no complications, since the parent organization's 460th Field Maintenance Squadron and 460th Avionics Maintenance Squadron were stationed at Tan Son Nhut AB, where they were charged with maintenance of all base aircraft. Between them the two squadrons were equipped for the inspection, repair, tech order compliance, and, in some cases, fabrication of airframes, fuel systems, pneumatics, ECM, navigation and communications equipment, and Doppler systems, among others.[25] The 460th maintenance facilities did not perform IRAN or corrosion control as a major function, nor did these squadrons maintain or perform modifications on the special USAFSS equipment in the back of the aircraft. This work was accomplished by AFSS personnel and/or technicians employed by Sanders Associates, the developers of the ARDF system.[26] The KY-8 secure voice system and associated communications maintenance was performed by the 1876th Communications Squadron at Tan Son Nhut.[27]

At Phu Cat, the maintenance support for the 361st TEWS was accomplished by the 37th Field and Avionics Squadrons, as far as the aircraft themselves were concerned. Maintenance on the special back end electronics equipment was performed by AFSS personnel; KY-8 maintenance by the 1883rd Communications Squadron.[28]

When the 362nd TEWS was based at Pleiku, significant downtime was experienced with the EC-47Q aircraft. Primary cause for the long downtime--

and this was true of all "Q" aircraft--was the time required to change an engine. Engines, accessories, and propellers were not available at Pleiku. As a result, when an engine change became necessary, the engine had to be removed from the aircraft and flown to Cam Ranh Bay, where it was rebuilt and then flown back to Pleiku to be remounted. This process took from ten to 15 days. In addition, the 362nd did not have an in-house capability to work propellers; consequently, these also had to be sent to Cam Ranh Bay.[29]

The deployment to Da Nang solved this particular problem. The 366th Field Maintenance Squadron performed engine and propeller change for the R-2000-4 as well as the normal maintenance functions performed at Phu Cat and Tan Son Nhut. Special equipment, as well as cryptological and communications systems, received maintenance by AFSS and AFSC respectively, as at the other bases.[30]

The situation at Nakhon Phanom (NKP) was different. The 56th Special Operations Wing could provide only minor maintenance on the EC-47s. The five aircraft were on the 360th UE and necessarily rotated back to Tan Son Nhut on a regular basis for phase inspection and major maintenance, scheduled and unscheduled, as well as time compliance tech order (TCTO) work. The aircraft remained at Nakhon Phanom for 21 days or 100 flying hours, whichever occurred sooner, then returned to Tan Son Nhut. Until around the end of June 1970, the return trips were made via Don Muang Airfield, Thailand, and the "Bamboo Route" across the Gulf of Siam. After

the fall of the Sihanouk government in Cambodia allowed the use of the airspace over that nation, to-and-from flights were fragged for missions transiting Cambodia between Nakhon Phanom and Tan Son Nhut.[31/]

Only eight of the 360th TEWS aircraft were used in the NKP rotation--all of these being ALR-34-configured to avoid complicated maintenance--because mission priority required CCZ-configured EC-47s (aircraft containing two extra collection consoles). The planes normally remained at Tan Son Nhut for five days, during which AFSS technicians repaired, tuned, and "peaked out" their special equipment; the same schedule was applied to KY-8, cryptological, and associated communications equipment.[32/]

CORROSION CONTROL AND IRAN

Every two years, alternating with corrosion control, IRAN affected the deployed EC-47s. IRAN for the TEWS aircraft was performed at Taichung, Taiwan, where Det 9, AFCMC, made inputs to the contractor, the Chinese Nationalist Air Force. All sensitive equipment had, of course, to be removed prior to sending the aircraft to IRAN. The Director of Materiel Management, Robins AFB, Georgia, directed the IRAN program by individual serial number of the aircraft, through the Director of Materiel at Seventh Air Force, and the contract stipulated a turn-around time of 43 days, not including the flight time and from South Vietnam.[33/] Aircraft in IRAN were removed from the TEWS "possessed" category for the duration of their absence.

Corrosion control was accomplished every other year, at Kadena AB, Okinawa, under the 313th Air Division facilities there (DMCC). Again, all sensitive equipment was removed before ferrying. Excluding the flight time of two days each way, corrosion control took 18 to 19 days to complete, and also removed the aircraft from the "possessed" category for that period of time.[34/]

MAKEUP AND LOCATION OF UNITS AS OF JULY 1970 (AUTHORIZED)

Tan Son Nhut - 15 CCS & 5 CC	Phu Cat - 19 CC
Da Nang - 13 CCZ	NKP - 5 CCZ

CHAPTER III

PERSONNEL AND EQUIPMENT IN SEA ARDF

Considerations of sensitivity preclude any detailed description of all the duties and functions of each crew member; however, each EC-47 mission was not necessarily limited to a "single function," e.g., ARDF. Airborne radio direction finding was indeed the primary mission for EC-47s in South Vietnam, but extensive COMINT (Communications Intelligence) collection was also routinely conducted on a daily basis from aircraft properly configured for the purpose.

The 460th Tactical Reconnaissance Wing Manual 55-1, discussing the types of missions flown, stated:[1/]

> *The primary fixing mission objective is fixing enemy radio transmitters. The entire mission is planned to obtain the maximum number of high quality fixes.*
>
> *The primary collection mission objective is to copy the text of enemy transmissions. Although targets are fixed on these missions, it is only accomplished when it does not interfere with the "Z" operator's performance of his duties. Keeping the aircraft in range of the transmitter that the "Z" operator is working takes precedence over fixing.*

The fact that COMINT (by air, ground, or naval facilities) was conducted was not unknown to the enemy. In his own words (from a CICV* document on Enemy Electronic Warfare Capabilities) the enemy used

* Combined Intelligence Center, Vietnam

it himself, and stated that the goals of technical EW reconnaissance were accomplished "through direction finding, monitoring, and exploitation of all information collected on communications systems, voice and Morse."[2/]

The same document, in a CICV conclusion, said that:[3/]

> *. . . It is not known how much electronic warfare has aided the enemy, but it must be concluded that if the NC/NVA are able to monitor friendly communications, they have the potential to exploit any compromised information.*

It is a prime precept in any intelligence gathering agency (even more so than in operational intelligence or long-range analyses) that "you don't compromise your cover." For this reason, EC-47 COMINT activities, conducted by USAFSS personnel, were kept strictly on a need-to-know basis, requiring an SI Category II clearance. The front end crews, aircraft commander, copilot and engineer (when carried) had to have Top Secret clearances, but not SSIR. The one link between front and back end crews was the navigator, until August 1970, when authorization was received to grant appropriate clearances to the front end crews as well.[4/]

460th TEWS CREW MAKEUP

In the early days of EC-47 work, the flight crews were made up predominantly of experienced and mature field grade officers, (80:20 ratio) many of whom had already accumulated considerable C-47 experience.

By mid-1970 this situation had changed to the point where the experienced/inexperienced ratio was approximately 40:60, the majority of front-end crews coming directly from UPT (Undergraduate Pilot Training), with no experience whatever in the venerable Gooney, and little or none in reciprocal engine tail wheel type aircraft. According to the 460th TRW, mission effectiveness was not diminished during the period of change.[5/]

The younger pilots' EC-47 upgrading started them out in the right seat as copilots, but, by the completion of their tour, most had been upgraded to the left seat as first pilots or aircraft commanders. It was not uncommon for them to log 1,000 flying hours in the EC-47 during their year's tour.[6/] For most missions the use of a flight engineer was discontinued, thus reducing gross weight (an increasingly important problem as more equipment was added) by 220 pounds, and, in addition, helping to solve the manning problem by deleting 45 spaces in the face of increased force reduction.[7/]

During the period covered by the first CHECO EC-47 report, Phase I navigator training was accomplished in the CONUS, but it was subsequently discontinued. At the time this study was written, all EC-47 navigator training was being accomplished in the combat area, in what was literally OJT, under the watchful instruction of standardization and evaluation navigators, supplemented by frequent checks by flight examiners. This reliance on OJT was necessitated by the lack of any arena in the United States that could effectively simulate the actual combat theater and experience.[8/]

EQUIPMENT UPGRADING

As of mid-1968, the 460th TRW had 47 EC-47N/P aircraft assigned. The EC-47N was powered by the Pratt and Whitney R-1830-90 engine; the EC-47P carried the same firm's R-1830-92, the only difference between the two being the accessory package. Both developed approximately 1,100 BHP (brake horsepower) on takeoff. The EC-47Q, not in-theater at that time, was powered by the PW R-2000-4 engine, developing closer to 1,350 BHP, a significant improvement in flight safety for the increasingly heavily loaded aircraft.[9/]

Of the 47 assigned aircraft, 30 were "CC" (Combat Cross)-configured--basically ARDF only--using the AN/ALR-34 system with "X" ALR-34 operator consoles, and "Y" acquisition operator consoles. Twelve were "CCZ"-configured, with the ALR-34, the "Y", and two "Zulu" COMINT acquisition consoles to provide extensive intelligence-gathering facilities. The CCZ aircraft were capable of both ARDF and COMINT collection. Five of the EC-47s had a configuration which consisted of the ALR-34, the "Y" console, and two "Q" consoles. The "Q" console had both acquisition and enemy communications disruption (jamming or spoofing of HF) capability.[10/] These aircraft were designated "CCQ."

As of midsummer 1970, TEWS-assigned aircraft had reached 55, of which 18 were CC, the remainder being capable of accepting "Z" consoles. The five aircraft with "Q" consoles were still carried on the board as CCQs, but in the interests of weight reduction and mission priority, the "Q" consoles had been removed, with the understanding that they could be

replaced within 48 hours should a threatening situation indicate the need for communications disruption.[11] (See Figures 2 and 3 for cutout diagrams of CC and CCZ configurations.)

THE ALR-34

The ALR-34 ARDF equipment was an extremely sensitive radio receiver designed to intercept signals from weak transmitters emitting in a power range of 0.5 to 10 watts or more over a frequency spectrum of two to 16 mhz* and designed to allow the operator-navigator team to determine an accurate bearing to the target over a large range of operational variables. The basic inputs to the system were aircraft heading information, aircraft position information, and phase angle-discriminated signals from the antenna system. The inputs were measured and processed in the ALR-34 operator (X) console, then consolidated and relayed to the navigator by a printout from the Franklin Data Printer.[12] The tape printout gave the navigator several items of information such as aircraft position along course (ALC), aircraft position across course (ACC), magnetic heading, time of day to the nearest second, signal strength, attenuation, and raw relative bearing.[13] From this information the navigator manually plotted a line of position (LOP) to the target.

This was the basic ARDF equipment in CC aircraft in 1968, and two years later the same gear was to be found in 20 of these assigned aircraft; while it was still, in 1970, also installed in 15 of the CCZ aircraft.

* A megahertz is equal to one million cycles per second.

The basic drawback to the system was that the navigator had to plot the relative bearings to his captive target manually, on the basis of the magnetic course, evaluate them for accuracy, then convert to true bearing.[14] Other limitations to the system were its limited standoff range, generally 20 miles (the greatest accuracy was at five to ten miles), and its relatively narrow frequency spectrum.[15]

THE ALR-35

Improvements to the ALR-34 capability began in 1968 with the installation of the ALR-35 in some EC-47s. This system coupled the basic ALR-34 with the Nortonics 1060 airborne data processor. It was designed to improve both quality and quantity of fixes and to provide for more rapid acquisition of fix positions. The interface of the two systems did not change the frequency spectrum, bearing accuracy, or input from the antennas, since the ALR-34 continued to be heart of the ARDF portion. The output from the Franklin Data Printer, however, was considerably different, since the automated portion performed many functions previously done manually by the navigator.

The 1060 processor compensated for induced airframe errors, converted the target magnetic bearings to true bearings, calculated the target location relative to the doppler set point, and determined the circular error of the fix.[16] It provided instantaneous readout of relative bearing to the target after one LOP was taken, continually updated range and bearing to target after two LOPs intersected, and computed the radius of the

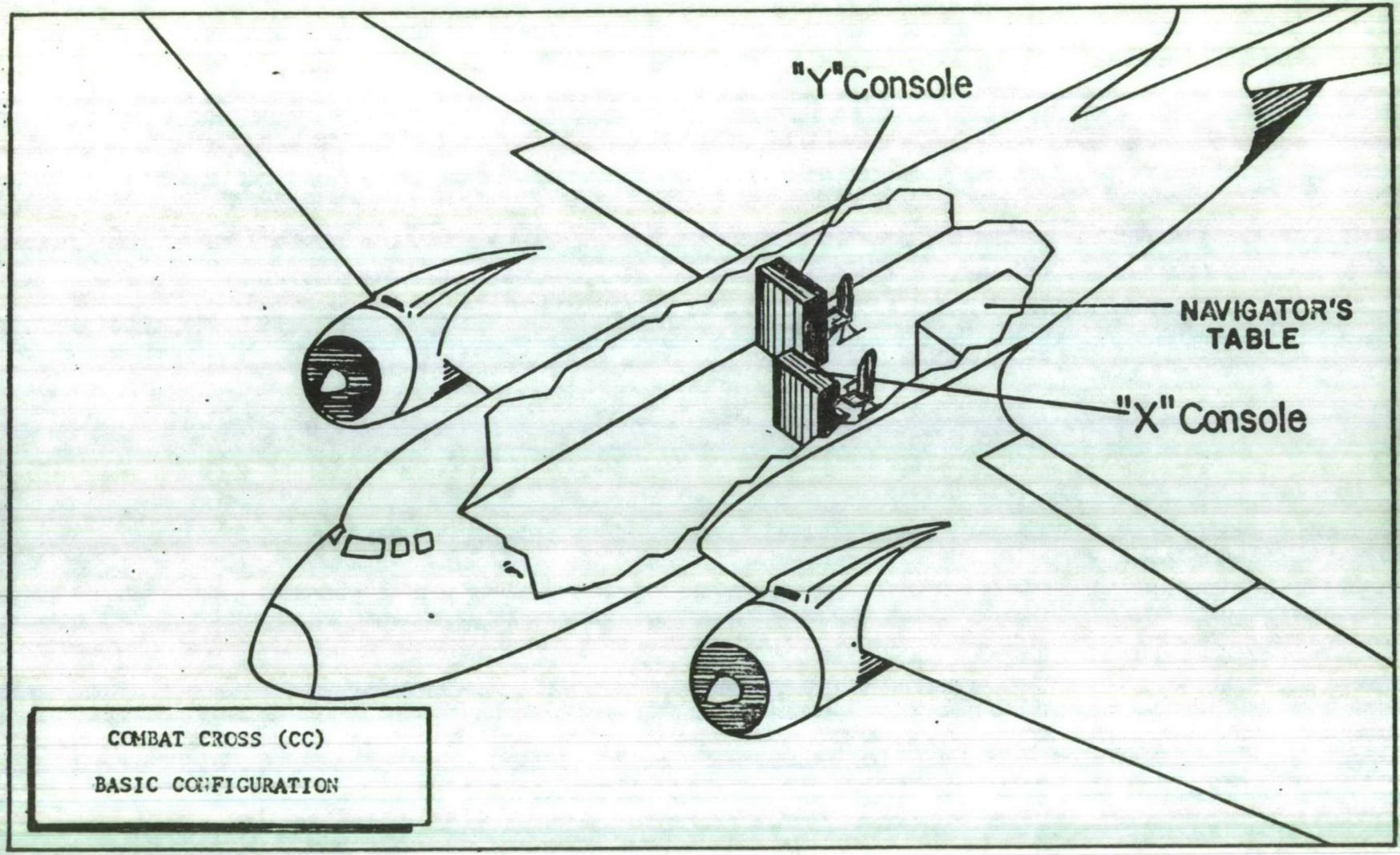


FIGURE 2

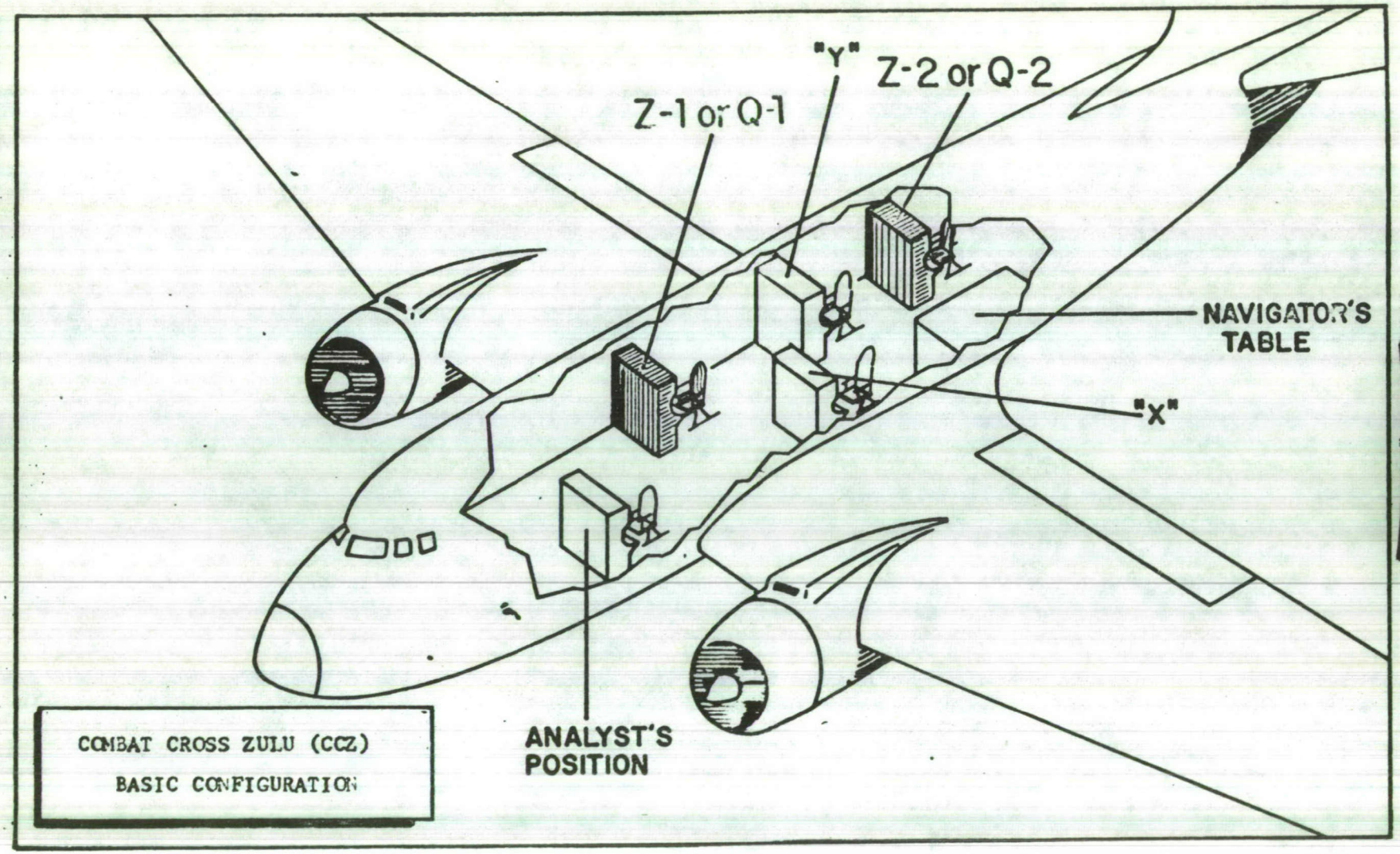


FIGURE 3

fix after three LOPs were taken. In addition, it simultaneously displayed relative bearing and range with each succeeding LOP.[17/] The zealous reader may obtain full technical data from the documents listed in the footnotes, but it was obvious that the ALR-35 gave the navigator additional time to position the aircraft more accurately for optimum data information. Figure 4 shows the ALR-35 control panel and keyboard (they were actually side by side on the console) by which the navigator controlled the equipment.

As of the summer of 1970, 14 ALR-35s had been installed in EC-47N/P/Q TEWS aircraft, but concurrently, a new system was being "married" to ALR-35 which would greatly increase its capabilities.[18/]

THE ALR-35/38

On 12 and 13 March 1968, representatives from Hq USAF, Hq TAC, Hq AFSC, Hq USAFSS, WRAMA, and Sanders Associates, the ALR-35 developers and contractor, met to discuss the addition of a VHF ARDF capability to the ALR-35. Initial discussions centered around a 25 to 75 mhz capability, but, as the meeting progressed, it became apparent that the equipment had an inherent capability to operate over a much wider frequency range than previously envisioned. Preliminary information indicated that this expanded VHF ARDF capability (16 to 150 mhz) could be acquired at little additional cost and with only a very slight delay in delivery.[19/]

Subsequent to the meeting it was determined that the modified ALR-35 could be made responsive to Steel Tiger VHF ARDF requirements if the

upper frequency limit of the modification were 180 mhz rather than the 150 mhz discussed earlier.[20] From these discussions came the ALR-35/38.

The first intimation of the proposed deployment came in September 1968 when CINCPACAF and Seventh Air Force were notified that the Air Staff was establishing an interim "Mini-Mod" program for Sentinel Eagle aircraft to be known as the "Mini-38" system. This action was taken to provide an immediate VHF DF capability in the two to 50 mhz spectrum, pending development of the full, or "Maxi-38," system. The message notifying Seventh Air Force of the proposed action said in part:[21]

> *First of three Mini-38s (installed in EC-47Q aircraft) will be available for deployment approximately 15 Nov 68; other two available approx 4 to 5 weeks later. Remaining Sentinel Eagle aircraft will receive ALR-38 mod, and Mini-38 aircraft will be upgraded on present schedule which provides ten VHF DF aircraft in SEA approx 4th qtr FY 69. Basic mod of seven aircraft and upgrading of three Mini-Mod will be done in field.*

The intent of the proposal was good, but the number of actually possessed aircraft was reduced by the loss of four EC-47Q model aircraft out of Pleiku. In August 1970, the 362nd TEWS/Det 2, 6994th Security Squadron, had five EC-47Qs configured with the ALR-38 equipment, covering the frequency spectrum from two to 190 mhz.[22]

THE DOPPLER SYSTEM

For any aircraft moving through space to "fix" accurately the

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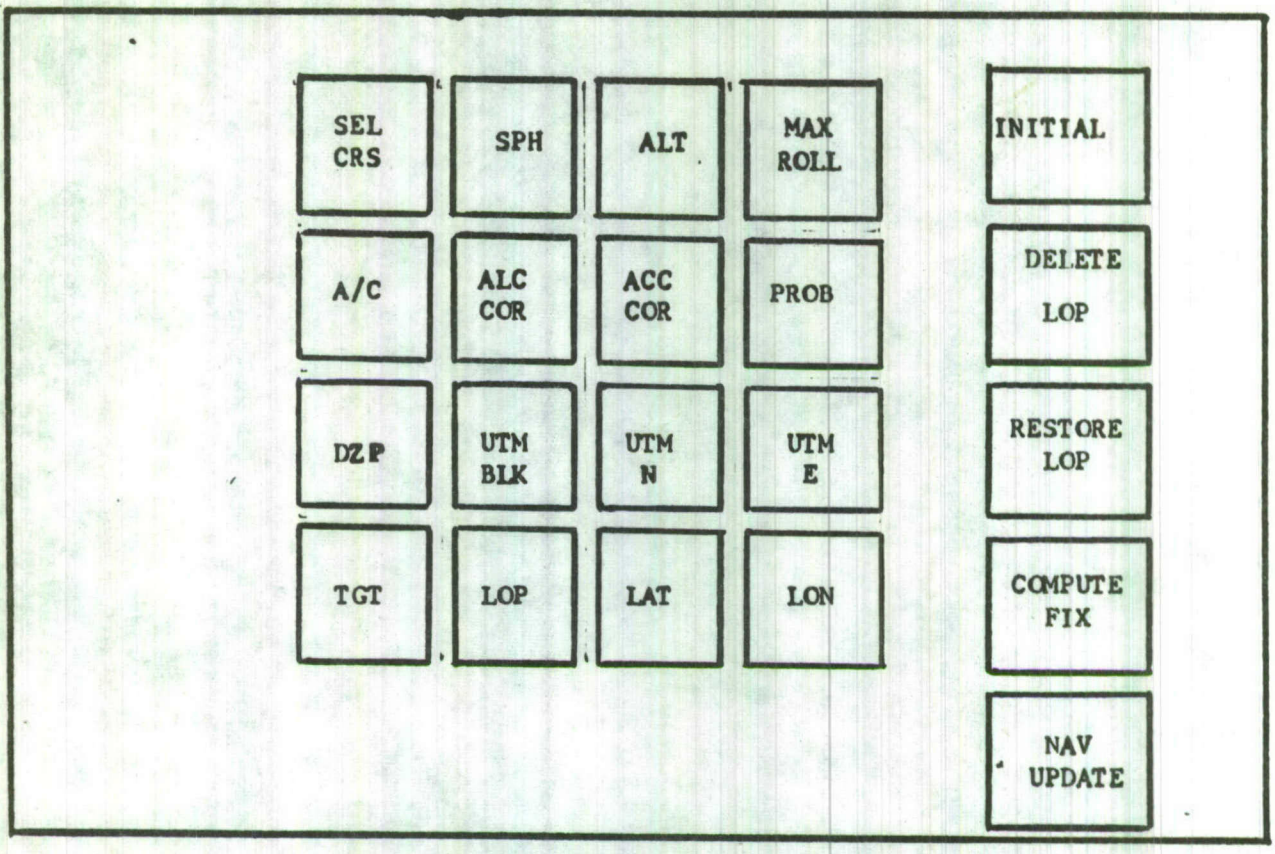
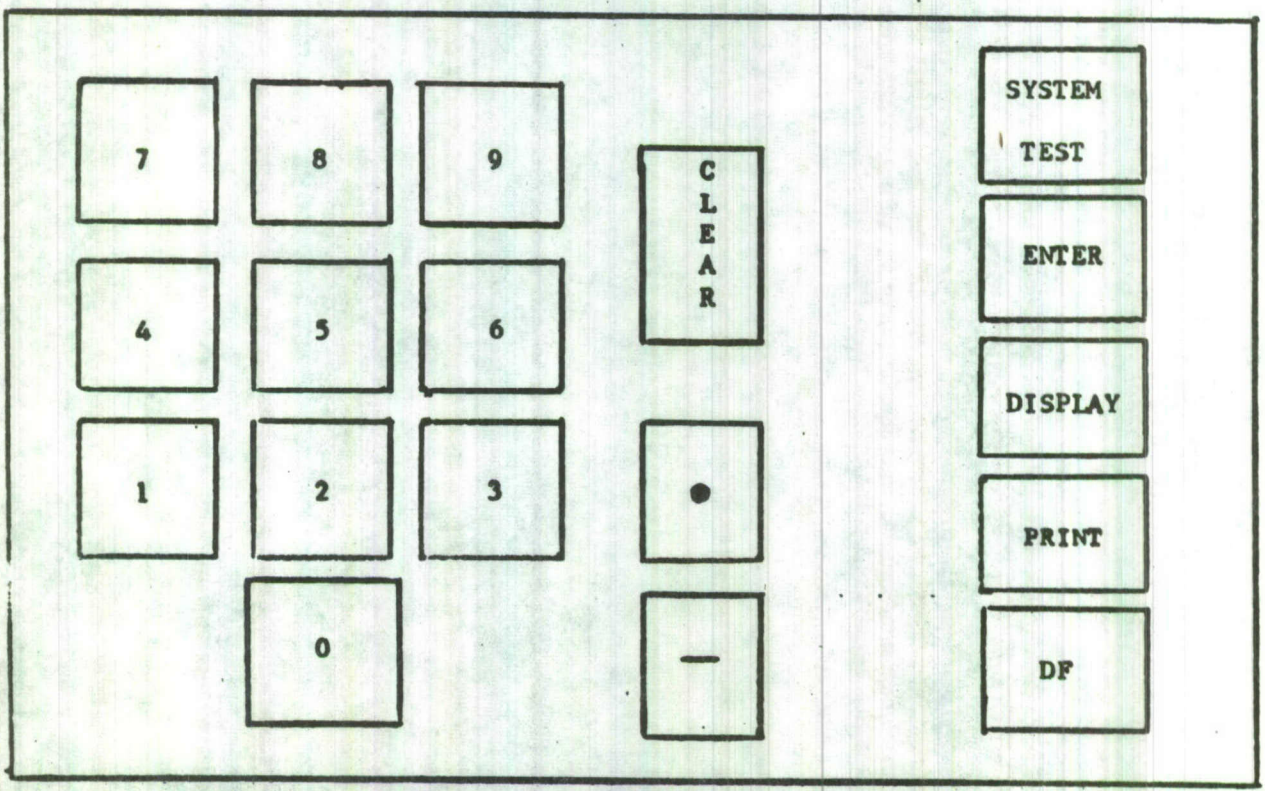
ALR-35 CONTROL PANEL



ALR-35 KEYBOARD



(Not to scale)

~~CONFIDENTIAL~~

FIGURE 4

position of a captive radio target on the ground, it was as important for the people in the aircraft to know their exact position as it was to have a readable signal and a precise intersection of a series of lines of position (LOPs). These would be meaningless if the position and heading of the aircraft were not known with extreme accuracy. To achieve this objective, EC-47 aircraft employed two primary navigation systems--the C-12 fluxgate compass system to provide accurate heading indication and the Bendix APN-179 Doppler radar navigational system to provide position over the ground.

The Doppler system consisted of three separate but interrelated units. The Doppler radar was composed of an antenna, flush mounted on the underside of the fuselage, a frequency tracker and receiver-transmitter located in the radio rack, and a ground speed and drift indicator at the navigator's station.[23/]

With the system operating, four separate beams of energy were radiated toward the earth's surface at 8,800 mhz. The signal was relfected back and picked up by the receiver-transmitter (RT) unit, having been shifted in frequency by an amount proportional to the aircraft's displacement from its originally set latitudinal and longitudinal position. The frequency tracker, using the RT information, provided inputs to the ground speed and drift indicator and to the Doppler computer, which integrated the information with that provided by the C-12 compass and relayed it to the computer controller. This

procedure provided the operator with the aircraft's position to within ± 0.1 nautical miles under "normal" conditions, i.e., equipment accurate, Doppler set-point reasonably updated, weather conditions reasonable, ground speed over 100 knots, and drift not exceeding 12 to 15 degrees.[24/] (Figure 5 depicts the operation of the APN-179 Doppler system.)

THE C-12 COMPASS SYSTEM

The C-12 compass system provided an accurate heading reference to the Doppler radar system, the ALR-34/35/38, and remote indicator on the aircraft. Useful at any latitude, the system used the gyro mode at higher latitudes and the magnetic mode at lower latitudes; in SEA, therefore, it was used only in the magnetic mode.[25/] The induction compass transmitter (flux valve, or flux gate) located in the right wing of the aircraft, electrically detected the horizontal component of the earth's magnetic field to provide the basic magnetic signal to the system. The directional gyroscope provided the basic heading stabilization for the C-12 system. With the system in magnetic mode, if the system heading did not agree with that of the induction compass, a heading error signal was developed. Applied to a slaving power amplifier, it produced an output to drive the gimbal of the directional gyro until the error signal went to zero. With other possible errors compensated internally, the C-12 was accurate at mid-latitudes to within 0.25 degrees at speeds up to 500 knots.[26/]

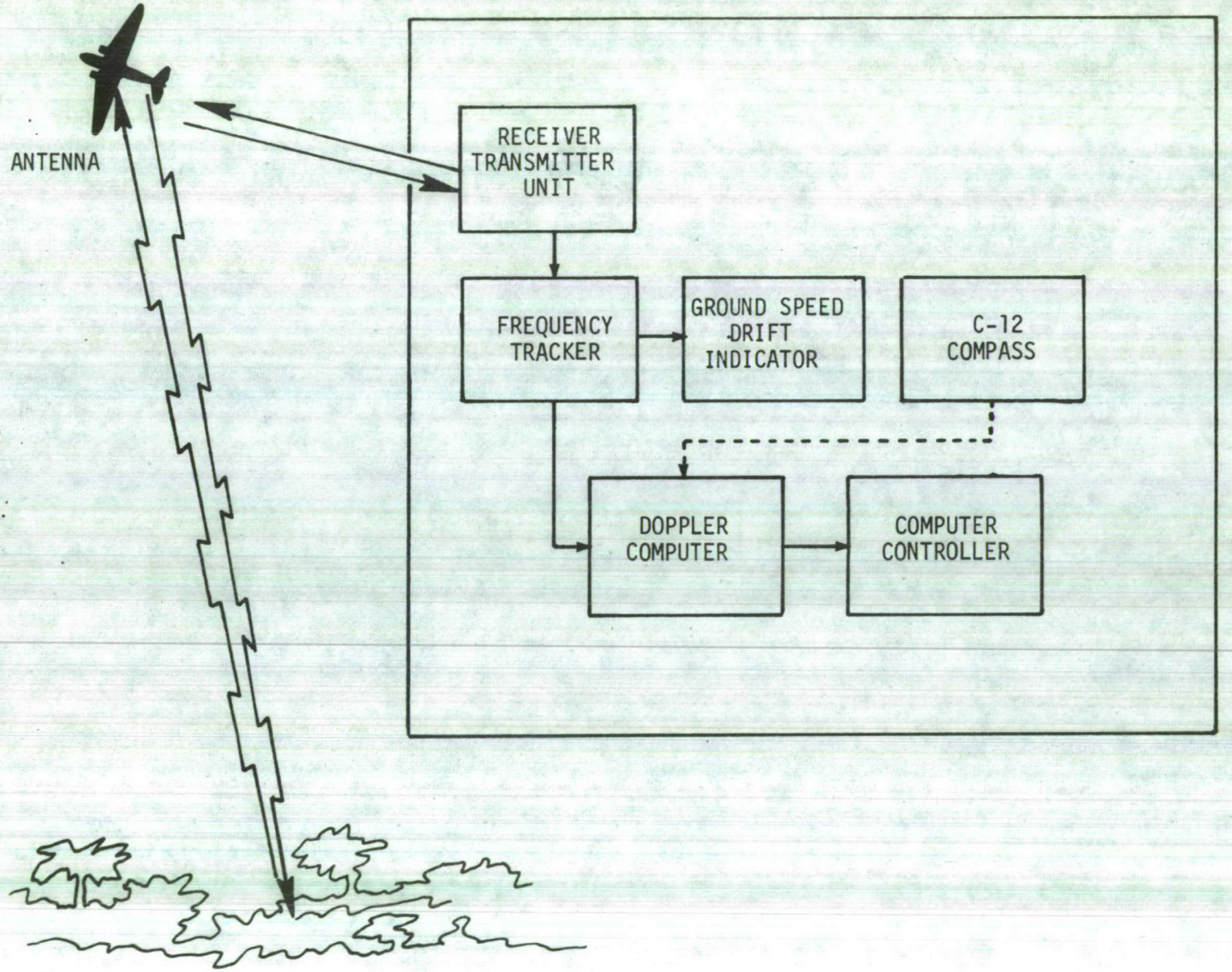


FIGURE 5

UNCLASSIFIED

THE B-3 AND B-6 DRIFTMETERS

For the Doppler radar system to provide accurate aircraft position, it had to be set initially over an accurately known geographical point, in relation to a Doppler zero point (DZP), and periodically updated throughout the flight with new Doppler set points (DSP). This was normally accomplished by the navigator using the gyro-stabilized optical B-3 or B-6 driftmeter. The aircraft was flown over an exactly known location, with the navigator giving the pilot directions, until the desired point appeared within the reticle of the driftmeter optics. The navigator then compensated for any error (three meters per reticle per 1,000 feet AGL) and made his Doppler set.[27/] Plans were in the mill at mid-1970 for day-night driftmeters to be installed in the 460th's EC-47s, the better to accomplish the night mission.[28/]

OTHER EQUIPMENT

The equipment previously described was essential to the ARDF portion of the mission. Other equipment was necessary for the COMINT portion, although the ALR-38 provided significant inputs with its frequency spectrum reaching up into the VHF range. Communications data collection consisted of a "Y" and two "Z" consoles in CCZ-configured aircraft. The "Y" console could accept monitor/record inputs from either the ALR 34/35/38 or from VHF and the long wire antenna. This communications data collection console could monitor amplitude modulated (AM), continuous wave (CW), or single side band (SSB) signals over a frequency range of

0.2 through 30 mhz. The "Y" operator also had access to FM (frequency modulated), HF (high frequency), and UHF (ultra high frequency) transceivers. The position also contained ciphered transmission control, and on those aircraft configured for communications disruption could control two jamming channels.[29/]

THE "Z" CONSOLES

The CCZ EC-47s were also configured for installation of two additional communications data collection stations. These were known as Z1 and Z2, Z1 being located forward of the "Y" console and Z2 located aft. The Z1 housed two receivers--either two HF receivers, or one HF and one VHF receiver. The Z2 console housed two HF receivers. Both consoles contained magnetic tape recorders for recording communications data from the receiver outputs.[30/] The "Y" console also housed a recorder which permitted the output of either or both receivers to be taped while the operator was engaged in analysis of another signal.

It is apparent that, with two receivers in each of the "Z" consoles, two in the "Y" console, and one in the ALR 34/35/38, in addition to three recorders, each CCZ aircraft was capable of collecting a great deal of communications data simultaneously.

THE KY-8 SCRAMBLER

Secure air-to-ground communications data exchange was made possible with the installation of the additional UHF and VHF transceivers in the

back and without disruption of routine aircraft communications from the cockpit. Secure speech through either of these was made possible by the addition of a KY-8 scrambler, a speech security device which operated in various radio systems to permit secure transmissions of classified or sensitive information over open channels. It was used for real-time dissemination of fixes or communications data to Direct Support Units (DSUs), and other intelligence or operational agencies.[31]

CHAPTER IV

OPERATIONS

Space limitations and technical differences in the operation of the ALR 34/35/38 systems preclude a detailed description of the ARDF function in this report. Explicit descriptions of each aspect of the various systems may be found in 469th TRWM 55-1 and in "A Critical Review of the ARDF Operations in SEA" by the 460th Tactical Reconnaissance Wing, both of which are excellent reference sources.

A simplified description of ARDF operations as conducted by EC-47s in 1970, may, however, be given. Primary considerations in fixing of enemy radio transmissions included knowledge of the aircraft's accurate position and heading, as determined by the Doppler radar system and the C-12 compass, acquisition of the enemy's signal, and subsequent tactics used to determine his location.

As soon as possible after takeoff, the navigator set the Doppler over a known point, with reference to a Doppler Zero Point. Since the Doppler navigational computer was subject to an accumulation of errors, especially at the low speeds flown by the EC-47, it was necessary to update the system every 20 to 30 minutes, or immediately following a fix, by flying over a known geographical point and resetting it. This was not always possible, because of night, weather, or terrain which offered no distinctive geographical points, but, in these circumstances,

other methods could be used to update the system. For example, Combat Skyspot (MSQ-77 radar), a highly accurate ground-based radar, could "skin paint" the aircraft up to 20 miles, or, if the EC-47 was equipped with an X-band transponder, up to 100 miles, with a high degree of accuracy. Also, TACAN/DME could, within limits, be used to update the Doppler. Unfortunately, neither of these methods was considered as accurate as use of the driftmeter, and CEPs* had to be adjusted outward accordingly.[1/]

Since the ARDF function was a totally responsive one (transmitters could be fixed only when the radios were emitting), the first consideration was to position the aircraft so as to pick up signals from the low-powered radios. Most of the fragged areas were approximately 20 nautical miles in radius. Once there, it was up to the navigator to direct the aircraft within the area to provide maximum probability of picking up enemy radio emissions.[2/]

ARDF Operating Areas

For ARDF tasking purposes, MACV partitioned Southeast Asia into 20 areas of operation (see Figure 6). The twentieth area, Cambodia, was added following the Lon Nol government's granting of permission for Cambodian overflight.[3/] Within these areas, approximately 70 by 90 nautical miles in size, missions could be fragged for either "effective"

* Circular error probables.

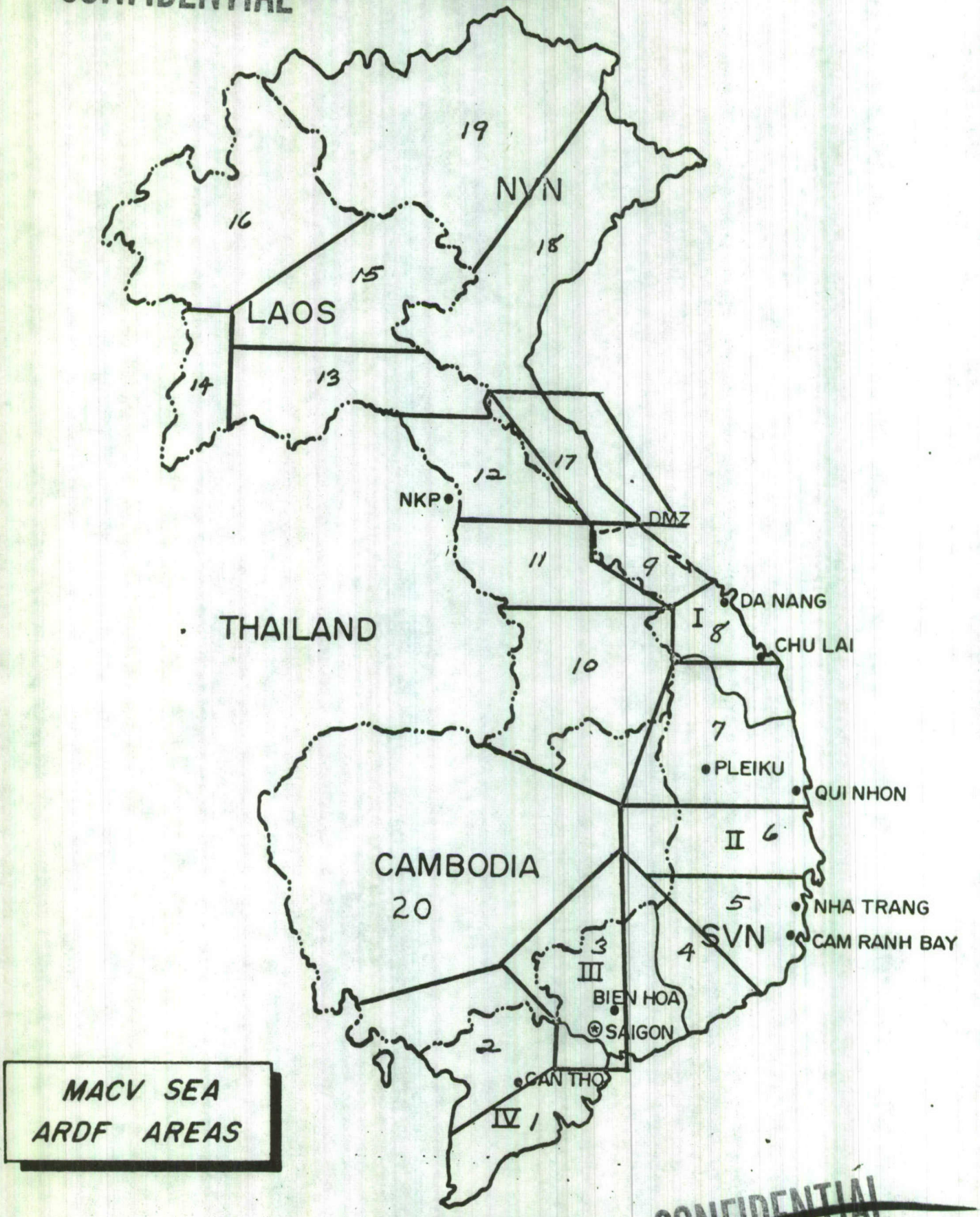
or "absolute" coverage. The effective coverage missions flew a general, or random, type of reconnaissance--intercepting, fixing, and analyzing any enemy transmission encountered within a specified geographical area. If, however, intelligence indicated a specific or general area of high interest, absolute coverage was assigned the fragged aircraft, the EC-47 normally orbiting within 20 NM of a specified point until acquisition was achieved, then fixing from five to eight miles from the captive radio.[4/] Over 95 percent of all USAF/ARDF missions were fragged for absolute coverage.

Because of the superior performance of the EC-47 (compared with U.S. Army platforms), most of the overflights of Areas 10, 11, and 12, as well as all deep penetrations of Cambodia, were executed by the Air Force. Nakhon Phanom-based aircraft were responsible for ARDF coverage of permissive areas of Barrel Roll within Laos, while aircraft of the 362nd TEWS at Da Nang normally had the responsibility for coverage of Steel Tiger.[5/] All other permissive areas were flown by either Air Force and Army aircraft, although the limited performance of Army aircraft led to their being restricted to shallow penetrations of Cambodia.[6/]

FIXING TACTICS

As a normal course of action, frequency search was conducted to and from fragged effective or absolute areas; however, unless intercepted information was significant enough to merit delay, the aircraft continued on to its target area. If the target was highly significant, the aircraft

~~CONFIDENTIAL~~ ~~SECRET~~



MACV SEA
ARDF AREAS

~~SECRET~~ ~~CONFIDENTIAL~~

FIGURE 6

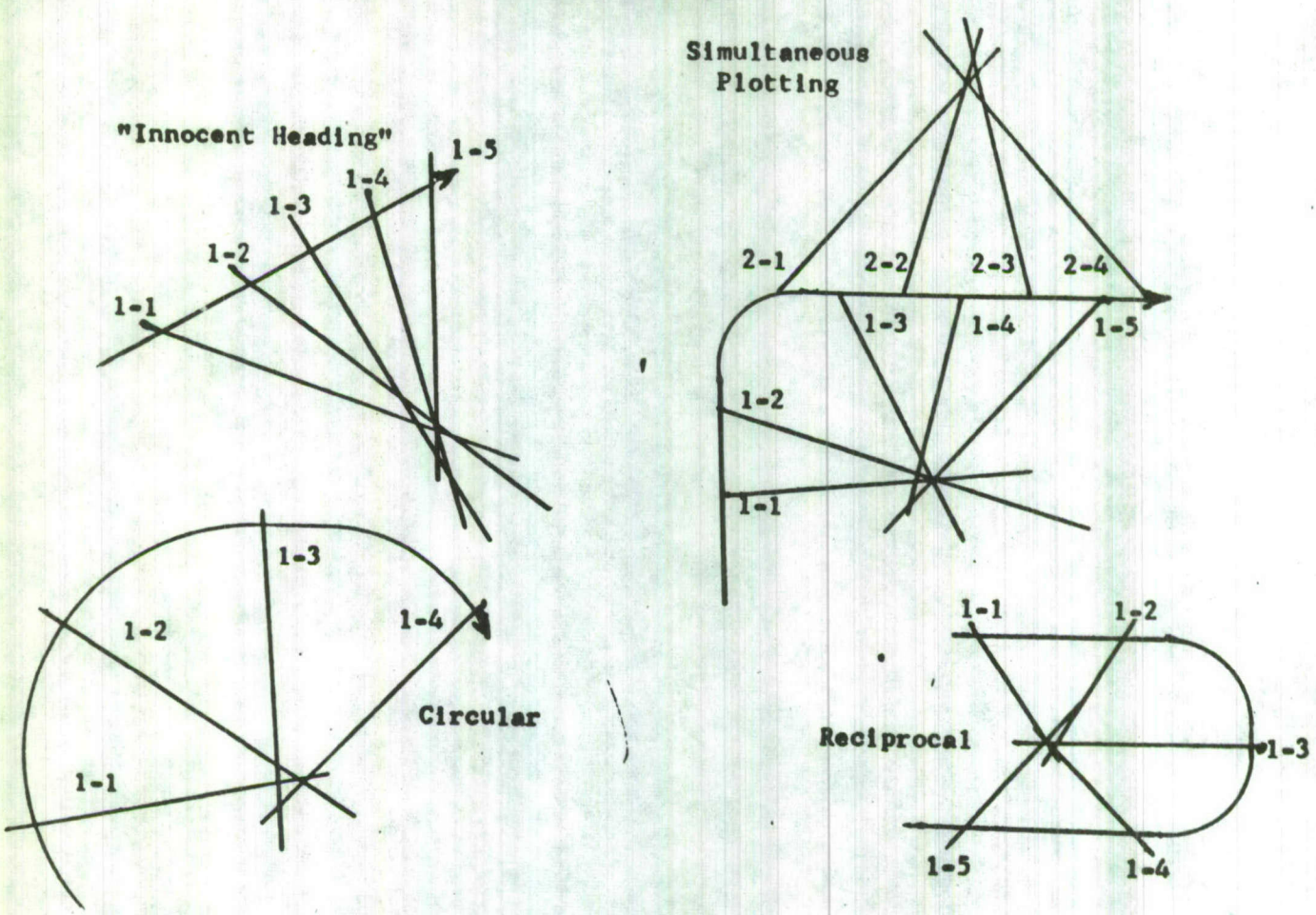
fixed the target, then proceeded to its initial destination. If, because of weather or unforecast threat, the aircraft was unable to work its assigned area, radio contact was made through the ROC (Reconnaissance Operations Center) with the ACC for diversion instructions. Final approval to deviate from a fragged mission could be granted only by 7AF through DOCR, on the basis of his knowledge of a definite threat in the area of proposed deviation. Even with receipt of 7AF approval, the final decision to deviate rested with the aircraft commander, whose determination was made only after due consideration of the potential hazards to flight safety.[7/]

Once in the fragged area, the procedure was for the intercept operators to search the frequency spectrum continually for significant transmissions. Once found by either a "Y", "Z", or "X" operator, the "X" operator locked the ALR equipment on, and the ARDF equipment displayed a relative bearing to the target. As of the first LOP, no substantive range information was possible, although signal strength and needle movement could give an experience navigator a fair approximation in many cases. Depending upon the information he had, the navigator positioned the aircraft in order to take subsequent LOPs. Two intersecting lines of position gave him a good idea of the enemy transmitter's range, as well as its position. Although six to ten LOPs were considered desirable, a navigator could accept a fix based on only three, if he considered them accurate.[8/]

An experienced "X" operator and navigator could and did take simultaneous fixes on more than one target, alternating frequencies as LOPs were taken and plotted. (See Figure 7 for methods of plotting fixes and types of fixes determined.) The most desirable method of fixing a target was to fly a single heading "innocent track" past the target, taking LOPs as they swung from nose to wingtip to tail. This was considered ideal for several reasons: one, the DF plane looked like any ordinary airplane just flying by to a ground observer; two, the stand-off range was good; and three, Doppler errors were kept to a minimum. However, the navigator used whatever pattern would give him the necessary results. If a target were transmitting intermittently, a circular or elliptical pattern might be used to keep the aircraft in a favorable position for taking an instantaneous LOP, should the radio come up for a short burst.[9/]

The judgment of the navigator was of prime importance in evaluating the accuracy (circular error probable) of the fix. Accuracy depended upon several factors, among them the known accuracy of the equipment, and the effects of weather and terrain upon given LOPs. Ideally, all LOPs should have intersected at a given point; in practice, however, the navigator usually had to do considerable editing, throwing out LOPs which, in his judgment, were faulty and retaining those which appeared accurate.[10/] The final step in the navigator's procedure was to assign a probable radius to the fix, ranging from 250 to thousands of meters.

TARGET PATTERNS



TYPES OF FIXES

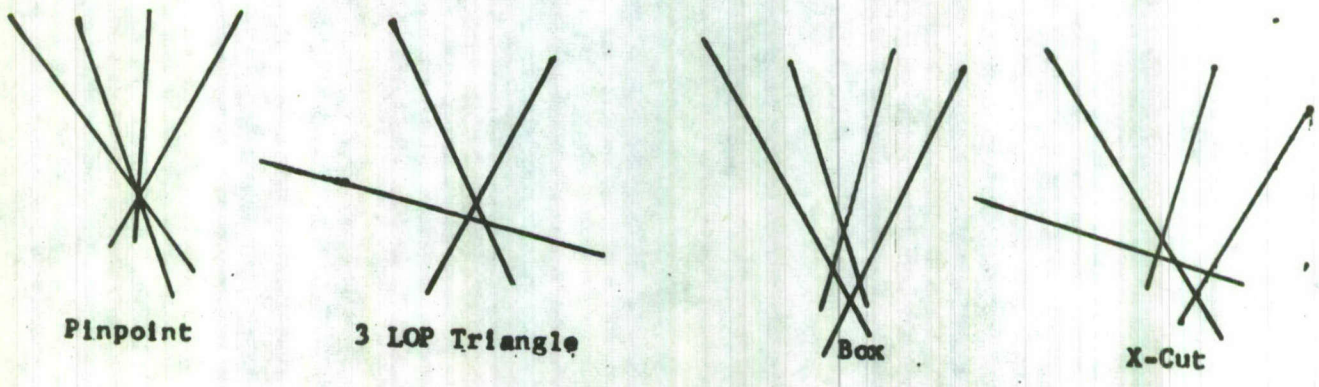


FIGURE 7

Influencing this determination were the time since the last Doppler update, the type of update (driftmeter, MSQ-77, TACAN, etc.), terrain effect, weather, and stand-off range.[11/]

Once the fix and its CEP had been determined by the navigator, it was passed back to the "Y" console operator for encrypted transmission to the ground-using agencies for action or inclusion into the intelligence data base. Since a large part of the data gathered, both fix and take, were highly perishable, speed was important, but not to the extent that it would degrade accuracy.[12/]

COVER TACTICS

Because the entire ARDF function depended upon enemy radio transmission, its success was heavily dependent upon the enemy's not knowing the aircraft's mission. Compromise would simply result in enemy shutdown of transmission, changes of frequency, or decoy transmissions from a tactically useless site. To counter this, the 460th Tactical Electronic Warfare Wing used several tactics for cover purposes: leaflet drops were made to simulate psyops aircraft, random patterns were flown--especially in absolute areas--and, until the USAF turned over its AC-47s to the VNAF, EC-47s were, at altitude, indistinguishable from them. The fact that the ALR equipment and the "Y" and "Z" consoles were passive, as well as the ability of the aircraft to work on targets from standoff distances of five to seven or eight miles, aided in the deception.[13/]

The KY-8 air-to-ground transmissions, while enciphered, were nonetheless "radio transmissions" and as such could be monitored for fixing--if not for content--by the enemy's own DF capabilities, and it was known that he had them.[14/] The possible effect of this potential enemy intercept upon the enemy's tactics was not known, but there were some indications that he was aware of a possible Airborne Radio Direction Finding, or Intelligence gathering function, since on many occasions he shut down transmission when an aircraft headed toward his position. This reaction occurred most often when Army aircraft, using aural null techniques, were forced to turn directly toward the enemy transmitter in order to obtain an LOP.[15/] The flight pattern of an aircraft using an aural null technique was easily recognizable to a trained observer. Having solved the problem of ambiguity, the aircraft would point toward the transmitter to obtain a "null" and an LOP. Next, the pilot would make an approximate 90° turn, fly what he considered to be about ten degrees of the radius of the emitted signal, perpendicular to the signal source. Following this he would turn back toward the station for another null, etc., until his LOPs converged for a usable fix. The distinctive "zig-zag" pattern of the flight would be easily identified for what it was, and it was this vulnerability which helped prompt the development of the phase-oriented system used by the ALR series, greatly reducing the possibility of mission compromise.

EFFECTIVENESS

It was not difficult for the Air Force to establish that the ARDF program was effective, thanks primarily to favorable comment contained in letters and messages received by the 6994th SS or the 460th TRW. Most of the COMINT data, however, remained in the U.S. Army's 509th RRG data bank as Category II special intelligence. As such it was handled strictly on a need-to-know basis, and was not generally fed back to Air Force channels. That information which could be sanitized was fed back through the 6994th SS to the TEWS, either through the parent wing or directly, and provided high motivation to the crews by giving them a real sense of mission accomplishment. Typical of the encomiums received by these units are the following excerpts from letters and messages:[16/]

> *. . . . The personnel responsible are to be commended for a job well done . . . such exemplary performance is the direct result of hard-working, dedicated, and mission-oriented people working as a cohesive unit, whether air or ground crew.*
>
> *Brigadier General William E. Potts, USA*
> *MACV J-2*

> *. . . . The Commanding General of the US 9th Infantry Division has expressed his pleasure over the excellent support provided him . . . it can generally be stated that your support enabled the tactical commanders of Joint Task Force Guadalcanal (Operation Utah Mesa) to keep track of the movements and location of units facing them and to plan their tactics accordingly.*
>
> *Hq 8th Radio Research Unit*
> *DSU, Hue Phu Bai, RVN*

. . . . Congratulations on a job well done . . .

General Creighton S. Abrams, USA
COMUSMACV

The messages cited are general in tone, and simply express an awareness and appreciation of the ARDF mission as prosecuted in Southeast Asia. Such awareness was shown from the top of the command ladder to the bottom. Far more specific and detailed were the reports forwarded by the ground commanders, using the information supplied them by the TEWS missions. The following excerpts from reports fed back to the 460th Tactical Reconnaissance Wing fully illustrate the timeliness, accuracy, and real-time intelligence value to the man on the ground. One such, from the 101st Airborne Division, stated:[17/]

ARDF is one of the prime intelligence sources for the 101st Abn Div. From the Commanding General, G-2, down to Brigade headquarters and S-2, this information is continually sought. ARDF is of the highest quality when its timeliness is taken into consideration. Between 40 and 50 percent of all ARDF comes in identified. Average time for dissemination of info, between 5 and 15 minutes after receiving info at this station (265th RR Co). Examples of ARDF usefulness: In March, 1st Bde, 101st Abn Div, was to launch a combat assault into LZ Susan. An hour before the CA (combat assault), a 750-meter fix was obtained at the location of LZ Susan on an enemy element. Artillery was employed and upon insertion 3 dead NVA were found at the location. In middle March, 1st Bde, using fixes on a number of u/i (unidentified) entities in one area, initiated a program where maximum fire power--Naval, Army, and Air Force--was placed in the area. This began around the 11th of March and at present time is still continuing. The 2nd Bde combat assaulted into fire base "Veghel" on 12 March. A fix on another enemy unit was obtained two days before by ARDF. Upon insertion two US were killed and 17 NVA were killed. The

3rd Brigade also went in on a Front 6 fix, finding complexes and overrunning Front 6 Headquarters. Two radios were found in the area and Front 6 was not heard from for over a week. The supported command is eager for this information. They do react in a timely manner on most fixes within their area of operations. The only shortcoming, they feel, is that there is not enough of this type information.

The last sentence was not a complaint, but a compliment, saying in effect, "The product is so good we'll take all we can get." That the product was both timely and accurate was undisputed; another favorable feedback said:[18/]

On 28 January 1969 a message was received at this station from MACV J-2 requesting that 6994 Security Squadron and 360 TEWS personnel place special emphasis on identifying and fixing a major NVA headquarters, as this entity was suspected of having relocated.

Less than 12 hours after the message had been received, the 29 January 09M missions had an enemy division wrapped up with a 500 meter fix. This location reflected a 6 Km westerly move on the part of the Headquarters.

Some 14 hours after the request, the 08C crew recorded a 12 Km southerly move on the Headquarters of a major NVA Regiment with a 500 meter fix.

Action taken in answer to a similar request elicited the following comments from the radio research unit involved:[19/]

On December 15, alert crews from the 6994th Security Squadron and the 360th TEWS were notified of a special mission to be flown that evening in response to a request by MACV J-2 (General Davidson) to identify and locate a specific headquarters. The recent relocation of this entity from the Cambodian Border area to an unknown location represented a direct threat to the Saigon area and was of top priority to field

commanders in the Capitol Zone Area. The 360th TEWS and 6994th SS, exemplifying the spirit and professionalism of the USAF ARDF effort, fulfilled the requirements levied on the mission by fixing the headquarters at 0120L, 16 December 1968. In addition, the mission obtained four targets that local Army units took action upon, expending a total of 188 rounds of artillery in so doing.

The following message was received from the Commander, 509th Radio Research Group, at Tan Son Nhut: 20/

The 25th Infantry Division Commander has requested that special emphasis and, if possible, special missions be flown against a specific division and its associated elements. This coverage was requested to support an upcoming offensive against these entities. Of the fifteen fixes and cuts by mission 809F on 24 July 1969, ten of these were considered priority tgts. The above results are specifically the type of result desired by J-2 MACV when they emphasize quality over quantity. The efforts of the personnel on this mission were outstanding, and their professionalism is to be commended. Please pass along our congratulations to the personnel involved.

The file of such favorable communications was voluminous, but those quoted suffice to show the value placed by Headquarters, MACV, the radio research units, the direct support units and the field commanders upon the USAF ARDF/COMINT accomplishments in Southeast Asia.

Another measure of effectiveness was through assessing the ability of the Tactical Electronic Warfare Squadrons to fly the missions and cover their target areas. Much of the value derived from ARDF/COMINT stemmed from the continuity of missions--identifying and following enemy units, keeping track of their locations and relocations, their advances

and retreats--and from the consequent ability to establish an Order of Battle (OB) without gaps or significant lapses. A scheduled mission not flown could "lose" an enemy unit, and reacquiring it could prove time-consuming; while the "lost" unit could pose a threat to friendly forces unaware of its location. Therefore, comparing missions flown against missions scheduled, and comparing "flying hours over target" with "hours over target requested," yielded another valid yardstick of operational effectiveness. The following eight-month In-Country Combat Sortie Summary for EC-47s shows part of the picture (the term EFFECT compares sorties over target with sorties scheduled, and is in direct alignment with target hours flown versus target hours requested):[21/]

	SCHED	CANX	FLOWN	DAY	NIGHT	EFFECT	INEFFECT WEATHER	INEFFECT OTHER
JUN 70	535	6	529	483	46	503	3	23
MAY	818	8	810	653	157	758	8	44
APR	742	4	738	658	80	695	0	43
MAR	816	8	808	741	67	777	0	31
FEB	740	2	738	636	102	697	0	41
JAN	852	2	850	677	173	840	0	10
DEC 69	903	7	896	706	190	876	1	19
NOV	992	33	959	821	138	934	3	22
TOTAL	6398	70	6328	5375	953	6080	15	233
PERCENT	100.0	1.1	98.9	84.0	14.9	95.0	0.23	3.64

So, of all the missions scheduled during the eight month period, 98.9 percent were flown. Of perhaps more importance was that of all the flying hours over target requested, 95.02 percent were accomplished by the TEWS. This figure continued to be maintained as of this writing.[22/]

Total sorties, by country and area, flown after July 1968, were as follows: South Vietnam, 25,460 (84.03%); Barrel Roll, 1,131 (3.73%); Steel Tiger, 2,490 (8.21%); North Vietnam, 708 (2.33%); Cambodia, 507 (1.67%), and one mission flown over Thailand in June 1970. No North Vietnam (Area 17) missions were flown after September 1969. In all, 30,297 TEWS ARDF sorties were flown during the two years.[23/]

The above figures cannot indicate whether individual mission objectives were met in each and every case. However, by both yardsticks--statistical data and customer feedback--the EC-47 ARDF/COMINT efforts in Southeast Asia earned a high rating. If consumer satisfaction was a criterion of success, the glowing reports fed back by the customers attested to its achievement. If getting the aircraft into the air and over the target measured effectiveness, then the Combat Sortie Summary offered corroboration. One last indication of their usefulness is to be found in the fact that even while other units and activities were already phasing down, the EC-47 TEWS grew to their greatest UE and assigned aircraft totals of the war.

Operating Limitations

The primary operating limitation connected with EC-47 operations in

SEA revolved around the mutual desire of MACV and the TEWS to provide maximum time for over-target coverage, coupled with the necessity to comply with the regulations stipulating a 100 foot-per-minute rate of climb in the event of loss of an engine on takeoff. MACV desired seven-hour sorties on all ARDF missions. With the EC-47Q and its more powerful engines, this did not constitute a problem, regardless of whether the aircraft was configured CC or CCZ. With the EC-47N/P in the straight Combat Cross configuration ("X" and "Y" consoles only) it, too, constituted no problem.[24/]

The difficulties arose with the EC-47N/P in the Combat Cross Zulu configuration, with its two extra "Z" consoles, associated equipment, and additional personnel. The seven-hour requirement could not be met, since the fuel needed for the mission would place the aircraft far under the 100 foot-per-minute rate of climb requirement. The takeoff weights remained the same for long or short missions, but the additional weight in the CCZ EC-47N/Ps forced a reduction in allowable fuel, in order to meet the weight requirements.[25/] Depending upon temperature, humidity and altitude (all of which affect engine performance), 27,000 pounds or a little less, was the maximum allowable gross takeoff weight. Approximately 200 fewer gallons of fuel (roughly 1,200 pounds) could be carried in the EC-47N/P CCZ aircraft--a loss which reduced their total sortie time to five hours.[26/]

Cruise control procedures whereunder pilots reduced power as fuel was consumed were instituted. By so doing, they enabled the aircraft to

maintain proper airspeed while using less gasoline. The net result was that as aircraft weight was reduced, less fuel was consumed, and aircraft sortie time could be extended to the maximum.[27]

It appeared to be a never-ending battle. As more equipment was added, new ways had to be found to reduce other weight. Leaflet drops, as a cover for operations, were discontinued to reduce weight (although the door was left open for their possible resumption). For the same reason, the use of a flight engineer on most missions was also discontinued. The "Q" (jamming) configuration was removed to reduce weight further.[28]

But for every step forward, it seemed that there was another step back. On 22 September 1969, Mod 545 installation of polyurethane foam in EC-47 fuel tanks was started. The purpose of the foam was to reduce the hazard of fuel fires or explosions, but the modification added 210 pounds to the basic weight of the aircraft and reduced fuel capacity by 4.5 percent--36 gallons. At 90 gallons-per-hour fuel consumption, this reduced sortie time by about 24 minutes.[29]

Much effort and paperwork went into a request for a waiver to reduce the 100 feet-per-minute restriction to 75 fpm on single-engine. Much of the controversy--and it turned out to be a controversy--hinged on the accuracy or inaccuracy of the C-47-1 performance charts, which differed from some flight test data. The issue involved 7AF, the 460th TRW, Hq PACAF, WRAMA, and the Air Force Flight Test Center for over a year,

without being resolved. As of this writing, it had still not been resolved; however, a mid-August WRAMA message said, in part, "New performance charts will be issued to replace T.O. 1c-47-1SS-7, dated 17 Feb 70. Charts will be available approximately 10 Sep 70."[30/]

Several other restrictions influenced Combat Cross operations, including friendly artillery areas, Arc Light strikes, congested flight areas, and susceptibility to enemy fire. The altitude restrictions imposed upon EC-47s depended upon the ground threat in the area being worked. Generally, over South Vietnam, 3,500 feet was the minimum altitude. Over Laos, where the threat was known, 4,500 feet AGL (above ground level) was the rule, and, when overflights of Cambodia began, 7,000 feet was the initial working altitude.[31/] In theory, the higher altitude--giving a longer slant range from aircraft to target radio--should have made the fixes less accurate, but in practice this does not seem to have been the case. In the opinion of the 460th TRW DCOE, 7,000-foot AGL fixes were apparently as accurate as those taken in South Vietnam; therefore, consideration was given to making the operating altitudes 7,000 feet above ground level in all areas. Obviously, though, in some areas of northern South Vietnam and in Laos, where the highest elevations ranged up to 10,000 feet, this would not be very feasible.[32/]

COMBAT LOSSES/DAMAGE

Notwithstanding the fact that in two years the EC-47s had flown over 30,000 sorties at altitudes which did not put them above all groundfire,

combat losses were minimal. The first EC-47Q model to reach South Vietnam, however, was lost 3 1/2 months after it arrived in theater. Its first tactical flight took place 28 November 1968, and it was declared missing in action 5 February 1969.[33/]

During the October-December period of 1968, four EC-47s suffered battle damage while flying combat missions. In addition, three EC-47s at Pleiku and one at Tan Son Nhut AB, RVN, were damaged by enemy action while on the ground. The extent of the damage to these aircraft was unknown.[34/]

On 30 September 1969 one EC-47 crashed during takeoff at Hue Phu Bai, following an operational stop at that base. The crash resulted in the injury of one crew member and extensive damage to the aircraft.[35/]

Scarcely one week later, on October 8 1969, an aircraft crashed while on final approach to Phu Cat AB, RVN. The aircraft commander had previously declared an emergency because of fire. There were no survivors from the crash.[36/]

An EC-47Q from Pleiku AB was struck by anti-aircraft fire on 22 April 1970 while operating in the Steel Tiger area of Laos, northeast of Saravane. The pilot attempted to keep the aircraft in the air long enough to reach a suitable airfield, but was unsuccessful and was forced to crashland it 24 nautical miles southwest of Hue Phu Bai. Of eight crew members aboard the aircraft, six were recovered by search and rescue

efforts; the other two were KIA. Because of the sensitive equipment still aboard the EC-47, it was destroyed on the ground by demolition charges and air strikes.[37/]

On the evening of 19 May 1970, an EC-47 parked in a revetment at Pleiku AB, sustained a direct hit during an enemy rocket attack and was totally destroyed. Another EC-47 in an adjoining revetment sustained minor shrapnel damage to the nose of the aircraft. It was estimated that the second aircraft would be in a flyable condition the next day. There were no personnel injuries.[38/] Six days later, Pleiku was struck by another rocket attack, resulting in major damage to another EC-47.[39/]

All in all, the combat and operational loss rate remained excellent, in part because of the historically recognized toughness of the old Gooneybird, and in part because of the experience and training of the crews and maintenance personnel.

CHAPTER V

CONCLUSION

The value of the ARDF/COMINT mission, as conducted by USAF EC-47s in Southeast Asia, has been undeniably established and adequately documented. The future of the mission, in terms of doctrine, roles and missions, hardware, and eventual command and control, was, however, largely undetermined. This was not merely an Army/Air Force struggle for control of the mission; intestine differences as to where the program belonged existed within the Air Force itself, stemming in great degree from the overlap in function between electronic warfare and reconnaissance.

Hq 7AF's Assistant for Electronic Warfare outlined part of the complexity of the problem:[1/]

> *Future doctrine has not been fully formulated and spelled out, but work is underway. New platforms, hardware, techniques, and training programs have not been provided for, except that studies are being undertaken and there is some R & D work going on. It is hard to tell which agency or agencies would operate and control a future Electronic Warfare program.*

He went on to explain further the overlap and complexities of pinning down EW to one pat function. For instance, a Wild Weasel aircraft, configured with RHAW (Radar Homing and Warning) equipment, and armed with the AGM-45 Shrike or AGM-78 Standard ARM missile, sought out enemy terminal radar threats. As such, it was performing an electronic reconnaissance function. When its missile warhead exploded, however, the

Wild Weasel became a strike aircraft. The EB-66C's primary job was to obtain data on the enemy's electronic order of battle (EOB), by collection of electronic intelligence (ELINT). The EB-66B and E aircraft, on the other hand, were purely ECM in their mission, and fitted into neither the attack nor the reconnaissance category. Yet all were involved in electronic warfare.[2/]

The EC-47 with the "Q" console had the ability to jam or spoof enemy communications; this was an ECM function. Yet, unless the threat were to become such that it would be more advantageous to deny the enemy his communications, the airplane was more valuable as a finding-and-fixing and data-gathering platform. As things stood, the EC-47 was performing a reconnaissance and intelligence gathering mission. Because of these many overlaps with attack, reconnaissance, pure ECM, and intelligence areas, no clear-cut doctrine for tactical electronic warfare had yet been established.[3/]

For the duration of the Southeast Asia conflict, the question of who would control the ARDF/COMINT program could well become academic. The DEPSECDEF memo of 19 June 1968, and the CSAF and CSA agreement of 11 September 1967, respectively placed operational control of the ARDF function under COMUSMACV and held in abeyance a final decision on the future of the program.

All of the effects might not be fully felt until after the Southeast Asia war was over, but, even while the conflict continued, some of them

were becoming evident. The bulk of intelligence data gained were obtained by USAF sources, but because of their applicability to ground warfare in South Vietnam, most were reported and exploited by the Army, and all were retained in the 509th RRG technical data base by the Army. This meant that while the Air Force did the "collecting," the Army did the "keeping", and this "in-house keep" could conceivably provide them with a lever for expanding their fixed-wing capability in post-hostility years.

The Army's straight-line control of its own ARDF forces provided an impressive package, one which would look good on a briefing board in future years, even though the Air Force collection effort had far outstripped that of the Army. The Air Force operated with separate front end and back end crews from the inception of the program. Because of difficulties encountered with the split operation, Aerospace Operational Doctrine manual, "Tactical Air Operations Electronic Warfare" (AFM 2-8), was revised to state:[4/]

> *Tactical Air Command (TAC) organizes and trains TEWS forces. Specialists from other commands (e.g., USAFSS) may be added when required for specific time periods under agreements negotiated by TAC with the other commands. Regardless of how the forces finally are constituted, they are deployed as units.*

In SEA operations they are deployed as separate units. "It brings up the organizational question of splitting responsibilities in an airborne intelligence activity between the 'operators' and 'collectors.'"[5/] Attempts have been made to change the situation, but, as of this date,

the 460th TRW and the 6994th SS continued to work under a Joint Operating Agreement (JOA), which at least delineated the responsibilities of each organization.[6/]

Air Force Manual 2-8 also stated:[7/]

> *The Air Force TACS is intended to provide the Air Force component commander with the necessary organization and equipment to plan, direct, and control all Air Force tactical air operations, including EW, and to coordinate these air operations with other services. Army requests for TEWS support are handled in the same manner as requests for other tactical air support.*

One can readily understand why the Deputy Secretary of Defense placed ARDF control under COMUSMACV to achieve centralized direction in a joint command, for the specific period of the war. At the same time, it could be anticipated that the Air Force might encounter difficulty in regaining the autonomy in EW operations contemplated by AFM 2-8. After all, the Army could claim full credit for the direction and control of the only existing ARDF and associated COMINT collection program for more than five years; and arguments against success are hard to muster.

FUTURE ARDF DEVELOPMENT

Regardless of the outcome of any doctrinal discussion, the state of the art of ARDF/COMINT should not be allowed to stand still. To do so would be to lose ground to other service or enemy technological advancements. Although the EC-47 ALR 34/35/38, "X", "Y", "Z", and "Q" console-configured aircraft performed an admirable job from 1968 through mid-1970,

there were nonetheless shortcomings whose elimination cried out for early action. Among the shortcomings were these:

- ALR-34 still required manual plotting.
- Standoff range limited to ten miles for accurate fixes.
- ARDF effective only against vertically polarized emission.
- Although UHF transmissions could be intercepted, ARDF did not have the frequency spectrum to fix them.
- Minimum acceptable fix set at 250 meters--over 800 feet.
- Airframe limited in interior space and subject to gross weight restrictions and short sortie time.

Hq USAF Requirements Action Directive of April 1968 proposed a plan for an upgraded Tactical Electronic Operational Support (TEOS) system. Although many of the proposed capabilities were subsequently incorporated into existing airframes, several problems or questions, including which aircraft were best fitted to carry some of the new equipment, had not been asnwered as this was being written. Among these future needs were the following:[8/]

- A means of manually or automatically detecting, identifying, and accurately locating HF, VHF, and UHF emitters up to 100 miles from the aircraft.
- Methods of accurately fixing transmitters, using either vertical or horizontal polarization.
- An ARDF system capable of fixing emitters, regardless of polarization, with accuracy on the order of 150 feet.

- A display system to depict simultaneously the location of the TEOS platform with respect to the ground environment, and the status of emitters within range.

- A radio fingerprinting capability to assist in emitter identification, regardless of whether the transmitter was CW or voice mode, operator change, or language used.

This report will not attempt to speculate on the outcome of these proposals or of those to come later, since doctrinal considerations have not been ironed out, and the end of hostilities could radically alter funding, role, and mission concepts. Much has been done in the ARDF/COMINT mission as conducted by the EC-47 in SEA. Its product and value have been proved. What more can or will be done remains to be seen.

FOOTNOTES

FOREWORD

1. (S) CSAF Msg to CINCPACAF and Addees, 251548Z Jun 70. (Msg Microfilmed on CHECO Document Collection System (hereafter cited as CDCS) cartridge TS-75, frame reference 103.

2. (S) Study, Subj: "A Critical Review of ARDF Operations in SEA," 25 April 1969, by 460th Tactical Reconnaissance Wing.

3. (S) Interviews with Lt Cols John Ritchie and Warren R. Paul, 460th TRW DCOE. Discussions with Maj E. E. Cohen, 460th TRW Standardization and Evaluation Flight Examiner (Nav). Also, (C) Discussion with SMSgt Carroll W. Miller, 6994th SS, 22 Sep 70.

CHAPTER I

1. (S) Project CHECO Report, Subj: "The EC-47 in Southeast Asia." Also (S) Study, Subj: "A Critical Review of the ARDF Operations in SEA," 25 April 1969, by 460th TRW. Hereafter cited as "460 TRW ARDF Review."

2. (S) 460th TRW ARDF Review, p 9.

3. (S) CHECO, "The EC-47 in Southeast Asia", p 11.

4. (S) 460th ARDF Review. Discussions with SMSgt Carroll W. Miller, 6994th SS, 22 Sep 70.

5. (S) Ibid. Also (S) Interviews and notes by Lt Col Franklin T. Roll, Hq 7AF DOCRE, between 15 and 23 July 1970. Hereafter cited as "Interviews with Lt Col Roll."

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(This page is UNCLASSIFIED.)

GLOSSARY

ACC	ARDF Coordination Center Across Course Correction
AFSC	Air Force Systems Command
AGE	Aerospace Ground Equipment
AGL	Above Ground Level
AM	Amplitude Modulated (Modulation)
Arc Light	B-52 Operations in SEA
ARDF	Airborne Radio Direction Finding
AUTODIN	Automatic Digital Network
CAS	Controlled American Source
CC	Combat Cross Configured
CCZ	Combat Cross Zulu Configured
CEP	Circular Error Probable
CHECO	Contemporary Historical Examination of Current Operations
CICV	Combined Intelligence Center, Vietnam
CINCPAC	Commander in Chief, Pacific
COMINT	Communications Intelligence
COMUSMACV	Commander, U.S. Military Assistance Command, Vietnam
CW	Continuous Wave Carrier Wave
DF	Direction Finding
DME	Distance Measuring Equipment
DMZ	Demilitarized Zone
DSP	Doppler Set Point
DSU	Direct Support Unit
DZP	Doppler Zero Point
ECM	Electronic Countermeasures
ECCM	Electronic Counter-Countermeasures
EOB	Electronic Order of Battle
EW	Electronic Warfare
FAC	Forward Air Controller
FM	Frequency Modulated (Modulation)
FOB	Forward Operating Base
H&I	Harassment and Interdiction
HF	High Frequency

IR	Infrared
IRAN	Inspect and Repair as Necessary
ISC	Infiltration Surveillance Center
ITOT	Initial Time Over Target
JOA	Joint Operating Agreement
KIA	Killed in Action
Km	Kilometers
LOP	Line of Position
LZ	Landing Zone
MACV	Military Assistance Command, Vietnam
NM	Nautical Miles
NSA	National Security Agency
NVA	North Vietnamese Army
OL	Operating Location
PACOM	Pacific Command
PAD	Phase Angle Discrimination Programmed Action Directive
RAD	Required Action Directive
RHAW	Radar Homing and Warning
ROC	Reconnaissance Operations Center Required Operational Capability
RRC	Radio Research Company
RRG	Radio Research Group
RRU	Radio Research Unit
RT	Radio Transmission Receiver-Transmitter
RVN	Republic of Vietnam
SAC	Strategic Air Command
SEA	Southeast Asia
SEAOR	Southeast Asia Operational Requirement
SI	Special Intelligence
SIGINT	Signal Intelligence
SS	Security Squadron
SSB	Single Sideband
SSIR	Special Security Investigations Required

TAC	Tactical Air Command
TCTO	Time Compliance Tech Order
TEOS	Tactical Electronic Operational Support
TEWS	Tactical Electronic Warfare Squadron Tactical Electronic Warfare System
TFA	Task Force Alpha
UE	Unit Equipment
UHF	Ultra High Frequency
USAFSS	United States Air Force Security Service
VC	Viet Cong
VHF	Very High Frequency
VNAF	Vietnamese Air Force
WIA	Wounded in Action
X	ALR-34/35/38 Operator's Console
Y	Acquisition/Collection Consoles
Z	Acquisition/Collection Consoles